



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

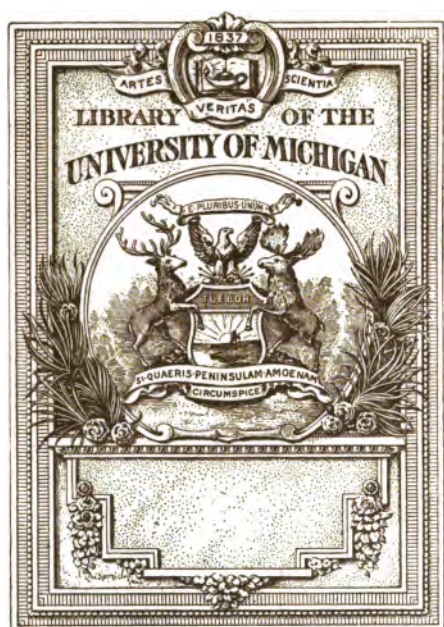
Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>



Forestry

SD

11

+A2

cop. 4

.....
.....
.....
.....
.....



TYPICAL LONGLEAF PINE (*PINUS PALUSTRIS*) OF THE TEXAS-LOUISIANA REGION.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF FORESTRY—BULLETIN No. 47.

GIFFORD PINCHOT, Forester.

FOREST RESOURCES OF TEXAS.

BY

WILLIAM L. BRAY,
COLLABORATOR, BUREAU OF FORESTRY.



WASHINGTON:
GOVERNMENT PRINTING OFFICE,
1904.

FORESTRY DEPARTMENT



LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF FORESTRY,
Washington, D. C., June 29, 1903.

SIR: I have the honor to transmit herewith a report entitled "Forest Resources of Texas," by William L. Bray, collaborator in the Bureau of Forestry, and to recommend its publication as Bulletin No. 47 of the Bureau of Forestry.

The eight plates, two text figures, and three maps accompanying this report are necessary for its proper illustration.

Very respectfully,

GIFFORD PINCHOT, *Forester.*

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
The forest	7
Natural conditions affecting the character and distribution of forest growth in Texas	7
Natural divisions of the State	8
Causes determining forest distribution in Texas	11
Rainfall	11
Nature of the soil and rock	13
Temperature	14
Sunlight	14
Winds	14
Classification of the forest	15
The east Texas timber belt	15
Swamp and bayou forests	16
Make-up of the swamp and bayou forest	16
Commercial value of the swamp forest	17
Hardwood forests of alluvial bottoms	17
Composition of the forest	18
Present condition of the forest	18
Loblolly pine and hardwood forest of the interior of the Coast Plain	19
Extent and character of the forest	20
Future of the forest	21
The longleaf forests of the Fayette Prairie	21
Area	21
Character of the forest	22
Rate of lumbering and future prospects	23
Hardwood and shortleaf forests of the Lignitic Belt	24
Extent	24
Composition of the forest	24
The shortleaf pine	24
The post oak forest	26
Agriculture in the post oak country	27
Timbered area of the Edwards Plateau and of hills and bluffs north- ward from it	28
Geographic relations of the species	29
The cedar brakes	30
Other hill timber	31
The live oak timber belt	32
The Rio Grande Plain chaparral	33
The mesquite	34
The timber of the Cordilleran Region in Texas	34
The timber of the foothills and slopes	35
The timber of the summits and high canyons	35

	Page.
Forest management	36
The prospects of private forest management in Texas	37
Conservative lumbering on virgin tracts of valuable commercial timber ..	37
Conservative lumbering in the longleaf pine forest	37
Conservative lumbering in shortleaf pine forests	39
Conservative lumbering in loblolly pine forests	40
Conservative lumbering in the hardwood forests of alluvial bottoms	40
Conservative management of woodlots	40
Forest extension	41
Conclusions concerning private management	42
Forest management and the State	43
Promotion of private management	43
What the State can do for private management	44
State management	45
Protective forests in the longleaf pine belt	45
Protective forests on the Edwards Plateau	47
Protective forests in the Lignitic Belt	48
Protective timberlands along water courses in the prairie region	49
Conclusions	50
List of valuable timber trees, native to Texas, with notes on their distribution, habits, and uses	51

ILLUSTRATIONS

PLATES.

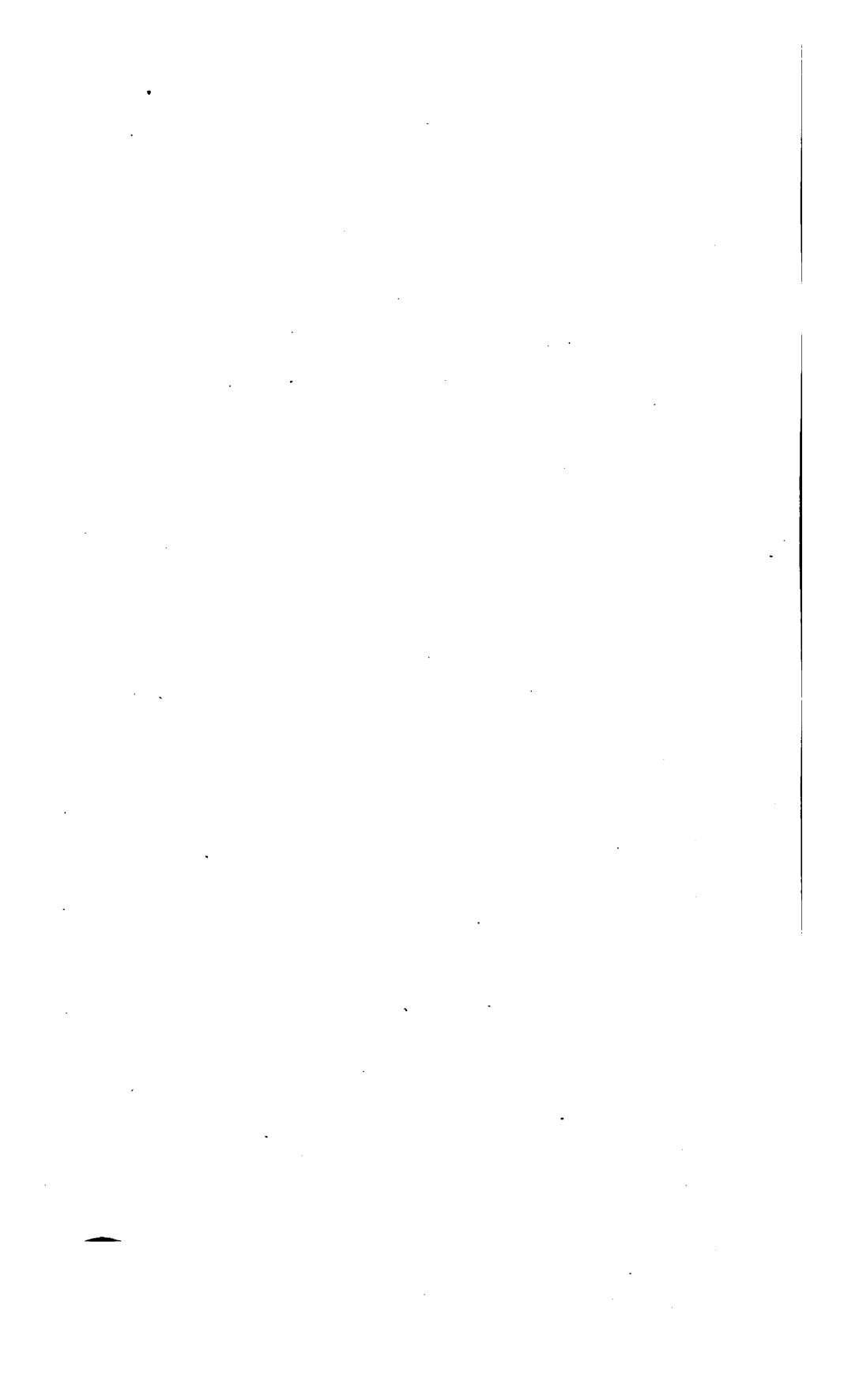
	Page.
PLATE I. Typical longleaf pine of the Texas-Louisiana region.....	Frontispiece.
II. Fig. 1.—Open shortleaf pine forest; heavy undergrowth of young pine, scrub oak, etc., on upland sandy soil near Garrison. Fig. 2.—Shortleaf pine deadening near Garrison; a good stand of large poles with many good trees destroyed to make a cotton patch.....	24
III. Fig. 1.—Deadened field of river bottom hardwoods near Garrison. Fig. 2.—Live oak encroaching on the coast prairie between the Brazos and San Bernard rivers in Brazoria County	28
IV. Fig. 1.—Cedar brake near Austin, which has grown up after a clearing twenty-five years ago. Fig. 2.—Thick growth of small mountain oak on the side of a deep gorge in the Edwards Plateau country near Austin.....	32
V. Fig. 1.—Characteristic view of the timber, mostly mountain cedar, on the Edwards Plateau, 20 miles northwest of Austin. Fig. 2.—Typical post oak forest of the Granite country in Llano County, looking across Fairlands Valley from Granite Mountain.....	36
VI. Fig. 1.—Longleaf pine land over eight years after logging; little or no progress toward reforestation on account of fires and grazing. Fig. 2.—Longleaf pine land in Jasper County immediately after logging operations, showing waste and débris, and the amount and condition of timber remaining uncut	40
VII. Fig. 1.—Typical swamp forest along the Neches River near Beaumont. Fig. 2.—Typical forest of mixed loblolly pine and hardwoods in the maritime belt; western edge of the "Big Thicket" country in Liberty County.....	44
VIII. Fig. 1.—Cow oak timber on the Trinity in Liberty County. Fig. 2.—Alluvial bottom forest on the Trinity in Leon County	48

TEXT FIGURES.

FIG. 1. Provinces and minor subdivisions of the greater Texas region	9
2. Precipitation in the Texas region.....	12

MAPS.

MAP I. Timber of Texas, omitting mesquite, chaparral, alluvial bottom hardwoods, and swamp and bayou forest	16
II. Approximate area and distribution of the alluvial bottom hardwoods.....	18
III. Distribution of mesquite in Texas.....	34



FOREST RESOURCES OF TEXAS.

THE FOREST.

NATURAL CONDITIONS AFFECTING THE CHARACTER AND DISTRIBUTION OF FOREST GROWTH IN TEXAS.

Within the State of Texas the natural conditions on which depend the range and make-up of the forest are of the most diverse character. In geographical position, its southernmost point lies almost in the edge of the Tropics, while its far northern portions are within the wheat and corn belt of the Middle Western States. Its climate varies from the even warmth of the coast lowlands, tempered by the ameliorating influences of the Gulf, to the rigors and extremes of the mountainous interior, and from the heavy rainfall and moisture-laden air of the east to the arid conditions of the western desert, with its dry, burning winds. In relief, the State rises from the sea level by diversified terraces to high plains 4,000 or 5,000 feet above the Gulf, and then to rugged mountains of the continental axis, which attain an elevation of nearly 10,000 feet. This vast terraced area has been further diversified by extensive erosion, which has carved and transported and built up again. The geological structure has resulted in the formation of soils of such divergent types as the alluvial bottomlands of the Gulf coast, the waxy loams of the prairies, and the wooded highlands and broken masses of the Plateau and Cordilleran Region. Corresponding to these differences in environment, the State presents a variety of forest types which passes from the swamp and bayou forest of east Texas, essentially the same with that of the States which border the lower Mississippi, through the great timber territory of the longleaf pine on the south, and to the north the no less extensive, though less valuable, region of the post oak, to the chaparral and mesquite of the Rio Grande Plain, and to the stunted bull pine and red fir of the summits and high canyons of the extreme west.

NATURAL DIVISIONS OF THE STATE.

The divisions of the State which are of significance for a discussion of forest growth are physiographic rather than geological. (See fig.

1.) They are the following:

1. The Coast Plain.
2. The Fayette Prairie.
3. The Lignitic Belt.
4. The Rio Grande Plain.
5. The Black Prairie, Grand Prairie, and Edwards Plateau.
6. The Central Denuded Region.
7. The Red Beds Prairies.
8. The Staked Plains.
9. The Stockton Plateau.
10. The Cordilleran Region.

(1) The Coast Plain, over 15,000 square miles in extent, is the low, flat plain lying along the Gulf, from which it has emerged in very recent geological time. It comprises a strip 50 miles in width, more or less, parallel to the Gulf and scarcely exceeding 50 feet in altitude at any point. The rainfall exceeds 50 inches at the east, but decreases to 30 inches soon after passing the ninety-seventh meridian. The Coast Plain from $97^{\circ} 30'$ westward may be arbitrarily included with the Rio Grande Plain. The soils of the Coast Plain, thus limited, consist of compact clays and silts, interspersed with areas having a larger proportion of sand, and therefore more porous soils. These latter are more easily captured by forest, the compact soils more slowly. Thus one finds alternating areas of forest and prairie. Where streamways cut across the Coast Plain a line of timber follows to the Gulf.

(2) The Fayette Prairie, containing 12,000 square miles, is a narrower belt of more uneven, undulating country, lying next inland and parallel to the Coast Plain. The rainfall conditions of the Coast Plain are repeated here; but the disposition of the water is different, owing to the deep beds of sandy clays and gravels which characterize the belt. The soil structure is especially favorable to timber growth. The Fayette Prairie east of the Trinity is occupied by longleaf forest. West of this the timber is mainly post oak, black jack, and live oak. These extend to the Nueces River, or farther; but the Fayette Prairie west of $97^{\circ} 30'$ will be classed as Rio Grande Plain.

(3) The Lignitic Belt, over 30,000 square miles in area, is an older geological formation (Marine Eocene), lying next inland from the Fayette Prairie. The altitude is greater, ranging from 200 to 500 feet, and erosion has left a much more uneven country than that of the two preceding divisions. Counting that portion west of $97^{\circ} 30'$ as Rio Grande Plain, the remainder comprises a large area of sandy clay ridges and hills, occupying all of east Texas interior to the Fayette

Prairie. The inner boundary runs approximately from Seguin (an arbitrary western limit) through Elgin, Cameron, Corsicana, and Sulphur Springs to the Red River. The open soil structure and heavy rainfall—especially eastward—make this a natural forest area, and in fact it is covered by the southwestward continuation of the Atlantic Forest Belt.

FIG. 1.—Provinces and minor subdivisions of the Greater Texas region. (From Hill's Phys. Geog. of Texas.)



(4) The Rio Grande Plain, of over 20,000 square miles, in a narrow sense would include only the Rio Grande embayment,^a but as here employed includes the western portions of the three preceding divisions, from about $97^{\circ} 30'$ to the Rio Grande. Its interior boundary is the escarpment of the Great Plains Region, whose southern province is the Edwards Plateau. The soils of the Rio Grande Plain are largely

^aHill, *Physical Geography of the Texas Region*, p. 2.

favorable for timber growth, but the low rainfall precludes the possibility of luxuriant forest. The woody vegetation consists of the characteristic chaparral, which is of arborescent height in the better watered parts, but becomes reduced to dwarfed shrubbery in the most arid areas.

(5) Next in series inland lies the vast Cretaceous Belt including the Black and Grand prairies and the Edwards Plateau, an area of some 40,000 square miles. The Black and Grand prairies are typical grass prairie country, possessing timber originally only on the bottoms and breaks of streamways and escarpment bluffs. Really the presence of these features, together with the intrusions of the two tongues of sand-bed country known as the Cross Timbers, brings a very considerable amount of timber within this typically prairie region. The rainfall would be sufficient to support rather heavy forest, particularly on the Black Prairies, but the very compact, waxy soil of these prairies and the impenetrable chalk beds of the Grand Prairie give grasses the advantage over woody vegetation in their struggle for the ground. The Edwards Plateau is very different. This is an area roughened by erosion, exposing the limestone strata to the reception of rainfall, which, though diminished to less than 30 inches, is still enough, under the physiographic conditions, to support a heavy though dwarfed timber covering. The Edwards Plateau embraces some 15,000 square miles from the southern province of the Great Plains Region. Toward the northwest the altitude increases to over 2,000 feet, and it merges at last into the Staked Plains. The southern border is very deeply dissected by erosion into a hilly, almost mountainous country, which is natural timberland.

(6) The Central Denuded Region is an area perhaps half as large as the Edwards Plateau, from which the Cretaceous strata have been eroded, exposing an area of granite at the south and of carboniferous sandstone at the north. Both are rough areas, with hills, bluffs, and gravelly flats or ridges favorable to timber growth. This is of post oak on gravelly ridges, of mountain cedar on hills, and of mesquite on flats.

(7) The Red Beds Prairies comprise an area approximating 10,000 square miles in north central Texas, abutting on the Staked Plains. Over this area the influence of altitude, distance westward and inland, and soils not especially pervious to water, leads to the complete predominance of grass vegetation except on streamways.

(8) The Staked Plains, with an area of 44,000 square miles, are, so far as soil conditions go, ideal for timber growth. The dryness of the region, however, does not permit timber growth of any kind except in canyons and on the escarpment bluffs. Where water is available, as about ranches, trees flourish to an unusual degree, and are hampered only by the severe winds.

(9) The Stockton Plateau is simply the continuation beyond the Pecos of the Cretaceous area of which the Edwards Plateau is a province. This is not a timbered country at all, except in canyons and on some rough breaks, where mountain cedar occurs. The arid climate and the compact adobe soils or rocky, *débris*-covered slopes are too unfavorable for timber growth. The Stockton Plateau extends to the eastern point of the Cordilleran Region.

(10) The Cordilleran Region comprises a vast area of over 30,000 square miles (including the Stockton Plateau), being part of the South Rocky Mountain Plateau. There are large tracts of high grass plains and scattered mountain masses, with intervening undrained pockets ("bolson flats"). The altitude in several instances is sufficient to increase the rainfall to nearly 20 inches, where the normal for that meridian is under 15. This and the fractured condition of the strata render these mountains capable of sustaining rather heavy timber of the Southern Rocky Mountains type. Especially noteworthy is the timber growth in the Guadalupe, Davis, and Chisos mountains.

CAUSES DETERMINING FOREST DISTRIBUTION IN TEXAS.

The principal natural influences which have determined the character and extent of forests in Texas are rainfall, nature of the soil and rock, temperature, sunlight, and winds. Of these the first two are by far the most important.

RAINFALL.

The rainfall of Texas decreases progressively from east to west. A map constructed to indicate the annual precipitation by 5-inch divisions would show a series of zones extending in a general north and south direction from the Sabine to the Pecos. Beyond the latter river the elevated mountain masses probably bring up the annual mean of rainfall, but at the westernmost boundary this average scarcely reaches 10 inches. (See fig. 2.) The limits of the several rainfall zones are approximately marked by the meridians of longitude. Thus, the ninety-fifth meridian about marks the western limit of rainfall exceeding 50 inches; the ninety-sixth, of 45 inches; the ninety-seventh, of 40 inches; and so on to the one hundred and second meridian, where the average annual rainfall has decreased to 15 inches.

Corresponding in a general way with these zones of rainfall, there is a series of zones of forests of different types. In the eastern region, having a rainfall in excess of 45 inches, are found the swamp and bayou forests of cypress, tupelo, water oak, swamp hickory, and other water-loving species; in slightly better drained localities, the black-gum, cottonwood, sycamore, beech, birch, and Spanish oak, and after them red oak, white oaks, walnut, pecan, magnolia, holly, and the

like. After these, on higher lands, come the pines, loblolly on the sandy knolls and ridges of the Coast Plain, longleaf on the more rolling sand barrens of the Fayette Prairie, and shortleaf on the higher uplands of the Lignitic Belt. The second forest zone consists of oak barrens, lying westward from the types of forest just mentioned, and in a rainfall zone of 45 to 35 inches. Next is the central Texas hill zone, with a rainfall of from over 30 to less than 25 inches, where occur mountain cedar, mountain oaks (five or six species), cedar elm, gum elastic, Mexican persimmon, and numerous others. Last of all come the pygmy forests of chaparral, embracing mesquite, retama, huisache, cat-claw, allthorn, palo-verde, and a score besides.

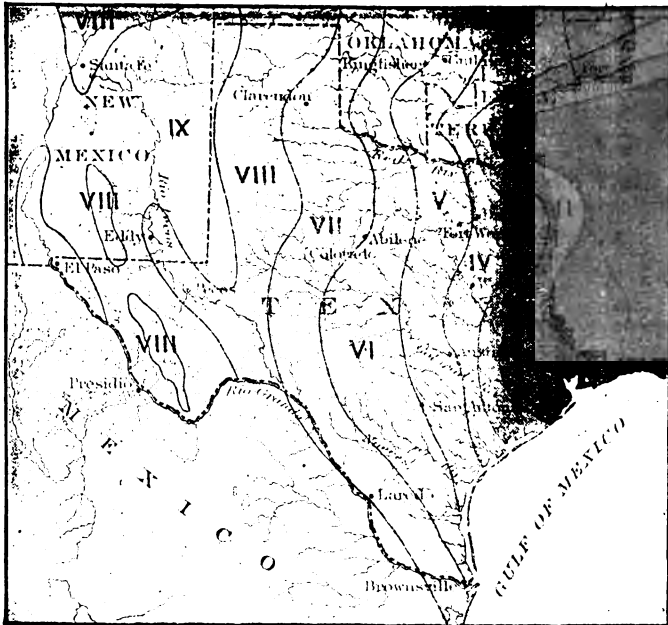


FIG. 2.—Precipitation in the Texas region: I, over 50 inches; II, over 45 inches; III, over 40 inches; IV, over 35 inches; V, over 30 inches; VI, over 25 inches; VII, over 20 inches; VIII, over 15 inches; IX, over 10 inches. More extended observations since the preparation of this map show a general slight reduction of the rainfall throughout this region.

Rainfall alone, however, does not determine the limits within which these species occur. There are canyons in the region where the annual rainfall is scarcely 20 inches in which may be found not only oaks, hickories, and similar trees, but even the swamp-loving cypress. While the moisture demands of the different kinds of trees constitute the most potent of the causes which determine their distribution, it is not primarily the amount of moisture which falls to the ground, but the amount of moisture which the soil holds that affects them. The distribution through the zones of rainfall is consequently modified very considerably by the varying geological and soil conditions.

NATURE OF THE SOIL AND ROCK.

The geological structure alone may account for heavy timber in regions of low rainfall, simply by the supply of percolating waters which it may furnish. The heavily timbered canyons of the Edwards Plateau as far west as Kerr County are an example of this. On the other hand, upon the pine barrens of east Texas, although the rainfall is heavy, the form and habit of growth of young longleaf pine shows very evidently its adaptation to periods when there is lack of sufficient moisture—a lack which the older trees partially overcome by sending their roots deep into the sand beds, through which the rain water drains away from the surface. In general, erosion canyons and the broken strata of mountain masses tend to make percolation waters available, and explain the relatively heavy timber in the far west of the State. So also the waxy clay soils of the Black Prairie, which tenaciously retain the moisture supplied by precipitation, support a forest growth which on more porous soils in the same rainfall area can not maintain itself. The swamp forests, the alluvial bottom forests, the loblolly and hardwood, and the shortleaf and hardwood forests are distinct forest types in a region of high rainfall, within which soil texture and chemical make up, configuration, and elevation are the determining factors. To understand the various types of forest which the State furnishes, it is necessary to take into consideration along with the rainfall the geological formation, the quality of the soil, and the physiographic features, which not only determine the minor classifications within each type, but also often broadly modify the types of large areas.

Nevertheless, it is rainfall rather than the nature of the soil and rock which has played the principal part in producing the main types into which the forests of the State naturally divide themselves. This is shown by the fact that the gradual transition from moisture-loving to drouth-enduring species takes place along the line of decreasing rainfall, and across the line of successive geological formations. These successive formations lie approximately parallel with the present Gulf coast, so that they traverse the rainfall zones nearly at right angles. It has already been pointed out that the forest belts follow a general north and south direction; in consequence they succeed one another along each geological formation. For example, the Fayette Prairie begins at the Sabine with very heavy forests of longleaf pine, which are succeeded west of the Trinity by post oak as the dominant species. As we advance southwestward this becomes more open and stunted, until at last it disappears in the dense body of the Rio Grande chaparral.

TEMPERATURE.

On the whole, the trees which compose the forests of Texas are those characteristically found in the southern part of the United States. The presence of palmetto, magnolia, live oak, longleaf and loblolly pine, and the mimosas attest this. On the other hand, not only do many species of the forests of the Middle States and even of the North Atlantic States occur, and indeed extend almost to the Gulf—such as hornbeam, ironwood, river birch, beech, and black walnut, with certain of the hickories, ashes, and oaks—but in the Guadalupe Mountains, where the State reaches its greatest altitude of 9,500 feet, there also appear the western yellow pine and red fir, species characteristic of the Pacific Northwest. Along these lines temperature is the dominant selecting agency.

SUNLIGHT.

The area of Texas presents extremes in the amount and intensity of sunshine which are reflected in the character of the forest growth. Thus, in the eastern forest area the most intense illumination is prevented by the blanket of moist atmosphere, and the duration of it is limited by the high percentage of partly or wholly cloudy days. In this area develop thick-crowned hardwood forests, having a heavy undergrowth of shade-loving species. In the Rio Grande country, on the contrary, the sun beats down with great intensity during the growing season, and its force is little weakened by the extremely dry air and the continuously unclouded sky. The trees which have been favored by this condition of light and dryness have a meager foliage, such as mesquite and the acacias, which hardly break at all the direct force of the sun's rays and give insufficient shelter to less intolerant, to say nothing of shade-loving, species. Except in moist canyons and on alluvial bottoms, the Texas region west of the ninety-seventh meridian is conspicuously wanting in shade-loving trees, and in fact in shade-loving vegetation of all kinds.

In contrast with the thick-crowned hardwood forests of east Texas are its characteristically open stands of longleaf pine, itself intolerant of shade, and entirely destitute of an undergrowth of shade-loving species.

WINDS.

The wind plays its rôle chiefly in hindering the encroachment of timber. Its power in this direction will be better appreciated when a more general attempt is made to start tree plantations on the open prairie. Orchardists in the Gulf region realize what the Gulf breeze is to contend against, and their orchards record the battle. In the coast region and on the Staked Plains the habitual direction and force

of the wind would have to be taken account of in choosing and grouping species for planting.

The periodical recurrence of Gulf hurricanes has had a profound effect on the history of forest extension and on the present aspect of the forest on the coast plain. For example, in the hurricane of 1875 a vast area of pine in Montgomery and San Jacinto counties was destroyed. Following the burning of the débris, a thicket of hardwood—especially scrub oak—appeared very generally, thus changing, at least for years, the type of the forest. In the hurricane of September 9, 1900, the loblolly pine and the white oak in the coast country west of the Trinity were blown down in enormous quantity, thus disturbing the forest equilibrium and consequently, for the present, the type. The most evident effect of these storms is written in the ragged, uneven growth of timber in much of the coast country. This is especially noteworthy on the lower Brazos and the San Bernard, and may easily account for the occurrence of an occasional veteran in a ragged forest of small trees and dense undergrowth.

CLASSIFICATION OF THE FOREST.

THE EAST TEXAS TIMBER BELT.

Formerly an unbroken forest of the same general character covered the great plain of the Atlantic and Gulf coasts, from Virginia through the Carolinas, Georgia, northern Florida, Alabama, Mississippi, Louisiana, and Arkansas to eastern Texas, and from the foothills and mountain slopes of the southern Appalachians to the sea. The common characteristics of this vast region, to which are due the general homogeneity of its forest, are abundant rainfall, low elevation, and warm temperature. Although the Coast Plain itself continues toward the Rio Grande, the further extension of this forest is checked near the Brazos River by the drier climate of the southwest. Here its vanguard is broken into straggling detachments, of which only the hardier push onward along the prairie streamways or up the deeper canyons of the hills. It is a striking phenomenon, this breaking up and gradual dwindling away of so vast and vigorous a forest. Not only in Texas, but far to the north, through the Indian Territory, Kansas, Nebraska, and the Dakotas, the same thing may be seen. Like a vast wave that has rolled in upon a level beach, the Atlantic forest breaks upon the dry plains—halting, creeping forward, thinning out, and finally disappearing, except where, along a river course, it pushes far inland.

This east Texas timber belt may be subdivided into the following types:

- Swamp and bayou forests, chiefly in the Coast Plain.

Hardwood forests of alluvial bottoms.

The mixed loblolly and hardwood forest of the interior of the Coast Plain.

The longleaf forests of the Fayette Prairie.

The hardwood and shortleaf forests of the Lignitic Belt.

SWAMP AND BAYOU FORESTS.

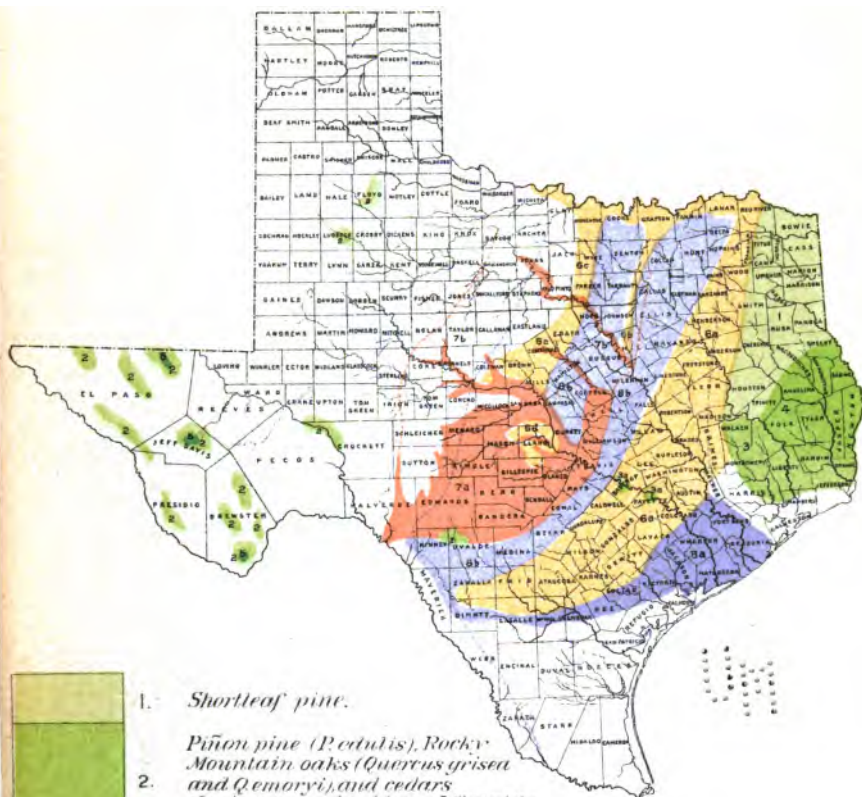
These forests are of the same character as the weirdly picturesque water forests of the Coast Plain in Louisiana. Along the lower Neches and Sabine rivers, at Beaumont and Orange for example, the type is as fully developed as on the bayous of the lower Mississippi or on the Calcasieu, at Lake Charles, Louisiana. Along all of the streams of the coast lowlands east of the Trinity the forests show to a greater or less degree the characteristics of this type, which follows them into the interior wherever they are sluggish and accompanied by swamps and bayous, as in the case of the big cypress, in Marion County. On the east these forests extend northward into Arkansas and as far as southeastern Missouri.


MAKE-UP OF THE SWAMP AND BAYOU FOREST.

The more important trees which compose this type of forest are bald cypress, swamp tupelo, water oak, swamp hickory, sweet gum, water ash, swamp maple, sweet magnolia, and black gum. Under these flourishes an undergrowth of many species of small trees and shrubs.

While all of the trees of these water-loving species ascend in places to higher ground to contend in mixture with other species for possession, the forest type which is produced by the exclusive association of these trees is confined to swamp land and the low borders of sluggish streams, where the water level in the soil is practically at the surface the year round, and where, for at least a part of the time, the ground is actually inundated, so that the lower parts of the trunks are submerged. Certain peculiarities of structure, as the expansion of the base of the trunk, and in the case of the cypress, the characteristic knees, mark their adaptation to such an environment. The compact, impervious clay and silt soil of the flat coast lowlands combines with the lack of drainage to produce conditions favorable to this forest type.

The relative representation of species varies greatly on different areas. In one place tupelo gum is dominant, in another cypress, elsewhere again swamp hickory. Such differences, however, due to local conditions which happen to have been especially favorable to some one kind of tree, do not alter the general type of swamp and bayou forest, which within its own territory retains undisturbed possession, no matter what may be the result of the competition for place among its individual members.



1. *Shortleaf pine.*

Piñon pine (P. edulis), Rocky Mountain oaks (Quercus grisea and Q. emoryi), and cedars (Juniperus pachyphloea, J. flaccida, and J. monosperma).
2. *Loblolly pine.*
Isolated bodies of loblolly pine on the Colorado River.
3. *Longleaf pine forest.*
4. *Western yellow pine (P. ponderosa), Limber pine (P. flexilis), Red fir (Pseudotsuga taxifolia), and other Rocky Mountain species.*
- 5a. *Post oak lands of the Lignitic Belt.*
- 5b. *Eastern "Cross Timbers."*
- 6a. *Western "Cross Timbers" and post oak of the Carboniferous area.*
- 6b. *Post oak of the Granite area.*
- 7a. *Main body of Edwards Plateau timber.*
- 7b. *Scattered bodies of Edwards Plateau type of timber on breaks and along stream bottoms.*
- 8a. *Coast Plain belt of heavy live oak, which is rapidly spreading on prairie lands.*
- 8b. *Prairie lands with scattered live oak.*

TIMBER OF TEXAS, OMITTING MESQUITE, CHAPARRAL,
ALLUVIAL BOTTOM HARDWOODS, AND SWAMP AND BAYOU FOREST.

GRAY LITH. CO. N.Y.

COMMERCIAL VALUE OF THE SWAMP FOREST.

In the Coast Plain of Louisiana the abundance of cypress makes the swamp forests very valuable. In Texas the cypress is not plentiful enough to be of special consequence. There is a fringe of it on almost all of the lowland streams, and there are some minor cypress swamps, but the best of this timber has already been cut, and what is left can probably be marketed with profit only in connection with lumbering of other species or of the swamp forest as a whole. A large amount of tupelo and other timber is available for cheap lumber for boxes, crates, and similar articles, but the demand for it scarcely exists as yet. At present what utilization there is of timber from these trees, as of black gum, for example, is drawn not from the swamp forests, but from those of the alluvial bottom type.

Ultimately a part of the land now occupied by the swamp forests will probably be turned into rice farms. It lies in the rice belt, and is better adapted by the conditions of its water supply to the cultivation of this crop than many areas which are now being developed for the same purpose. The apparently unlimited supply of cheap fuel furnished by the recently discovered oil fields of the region may stimulate new industries which will furnish a market for the great amount of timber material contained in this forest type. Should such be the case, the way would be open for the utilization of the timber now standing, as an accompaniment to the reclamation of the swamps for agriculture.

HARDWOOD FORESTS OF ALLUVIAL BOTTOMS.

These forests flourish in the broad erosion channels which the streams of east Texas have worn inland from the low-lying coast plain, chiefly in the Lignitic area. Prof. R. T. Hill describes this area as follows:

The drainage basins, because of the readiness with which the unconsolidated structure yields to erosion, occupy a far greater area than the remnants of the ancient plains in which they are carved. The present level of the rather sluggish streams is from 100 to 200 feet beneath the divides. Their flood plains are wide and somewhat unstable. A few feet above these bottoms are the inevitable accompaniments of all the major streams of the southern cotton belt, known as second bottom, often a mile or more in width. * * * The flat divides and wide valleys characterize the whole extent of the region.^a

An example of such a river bottom is that of the Trinity. For at least 100 miles of its course from Liberty northward the heavily timbered valley would no doubt average 5 miles in width. This would mean 500 square miles of chiefly hardwood forest. Similar bottoms are found along the Red River, Sulphur, Sabine, Neches, and Attoyac, besides many more of less extent.

^aR. T. Hill, *Irrigation*, 1893, p. 64.

COMPOSITION OF THE FOREST.

Associated in this forest are nearly all the well-known valuable hard woods of the Atlantic States, many of them in great abundance and perfection. First in quantity, variety, and value stand the oaks. Among the white oaks are the cow oak, bur oak, overcup oak, and the common white oak; of the black oaks, red oak, Texas oak, willow oak, and water oak. Next in importance comes ash, with white ash probably first and green ash second. The hickories are represented by the sweet and bitter pecan, shagbark, and white hickory. There is an endless quantity of gum, comprising sweet and black gum and tupelo, and much cottonwood, sycamore, and elm, with a fair amount of linn, white maple, holly, magnolia, ironwood, hornbeam, and, on some of the north Texas streams, bois d'arc (Osage orange). Black walnut, which was formerly common, has been largely cut out.

On the rich, loose bottom soil the timber grows very large. Oaks reach a diameter of from 3 to 6 feet, ashes of 2 to 4 feet, and hickories of 2 to 3 feet. The undergrowth is generally very dense, so that the forest covering is close and heavy. The intermixture of species is ordinarily very complete, though of course unequal; but not infrequently some one species has become predominant. An example of this is bur oak on certain tracts in the Red River Valley, near Texarkana, which on one tract pointed out to the writer stands so thick as to resemble in exclusiveness a pure pine forest. On the lower Trinity, the San Jacinto, and elsewhere, two of the white oaks are especially abundant. On the Red River cottonwood is very heavy; the largest of this, however, occurs more sparingly mixed with other heavy timber. On the Sulphur Fork black gum in places forms almost pure forest; in other places ash and hickory do the same. Thus particular localities become known as the sources of supply in quantity of particular trees. Other examples are the occasional areas of red cedar in the forests of this type, and the bois d'arc bottoms of a few counties along the Red River.

PRESENT CONDITION OF THE FOREST.

Much of this hardwood forest has already been cut. Along the older lines of railway it has generally been culled for 6 or 8 miles back, especially of the best oak and ash. Much of the ash along the Trinity has been rafted out, and the same thing is now taking place with the cottonwood of the Red River, at present much in demand for certain lines of finishing. The ordinary grades of oak have gone for ties, the better for staves, of which great quantities have been produced in recent years. Other hardwoods have until lately either been used for ties and other purposes of railway construction, or have been shipped out of the forest as logs. Now several mills are filling orders



APPROXIMATE AREA AND DISTRIBUTION OF THE
ALLUVIAL BOTTOM HARDWOODS.



for various grades of hardwood saw products, and furniture factories are working up some lumber into the more common articles of furniture.

In spite of these heavy drafts upon it, the great body of hardwood timber in east Texas remains to be harvested. What a resource is furnished by these noble forests of high-grade woods, suitable for manufacturing into the more valuable products of the mill, the single example already mentioned of 500 square miles along the Trinity above Liberty may illustrate. But its day is at hand. Not only are local factories being erected to work up the native hardwoods, but Northern concerns also, having consumed the timber in their territory, are eagerly reaching out for new sources of supply. Hitherto Arkansas has been the field of their southern operations; now they are beginning to turn to the better Texas areas. Here is at hand sufficient raw material to support for many years establishments for working up the forests into furniture, wagon timbers, implement handles, and all manner of things now shipped into the State from great distances.

Yet the manufacturer can come none too soon for the utilization of this great timber resource. So rich is the soil that clearing for settlement is outstripping the lumberman. Field after field of unsurpassed forest is being deadened and destroyed merely to get rid of the trees. The best thing that can happen in the interest alike of the private owner and the State is the rapid development of a market for this timber, which otherwise is likely to be largely wasted, although certain to be salable at a large profit within a few years, if the impatience of the owners to realize an immediate value could be restrained.

Along the streams the alluvial bottom timber extends into the inland prairie region to a noteworthy degree, but with so marked modifications that its discussion falls more appropriately under that of the prairie region itself.

LOBLOLLY PINE AND HARDWOOD FOREST OF THE INTERIOR OF THE COAST PLAIN.

At the Gulf the Coast Plain is a treeless, grass-covered prairie. Twenty miles inland tongues of forest are found, projecting down toward the Gulf. All the way from the Sabine to the Brazos, in passing through the middle of the Coast Plain—which extends from 50 to 100 miles into the interior—one traverses alternately belts of open prairie and tongues of heavy timber. These latter follow either the streamways or the elevated ridges of porous, sandy soil which from time to time break the continuity of the heavy prairie clays. Farther inland the forest becomes almost continuous and very dense, extending in this form over practically the interior half of the Coast Plain.

The tongues of forests along the streams belong partly to the swamp

and bayou type and partly to the alluvial bottom type. East of the Trinity they form the chief areas of swamp forest. Along the ridges, however, these tongues are the seaward extension of the mixed loblolly pine and hardwoods forest of the interior of the Coast Plain. In the stream basins the characteristic forests of the alluvial bottoms tend to run back into the loblolly and hardwoods forest, just as the latter follows the sandy ridges out into the prairie; but even in these streamways the loblolly gradually enters into the mixture.

EXTENT AND CHARACTER OF THE FOREST.

The loblolly pine and hardwoods forest was estimated by Doctor Mohr to cover an area of about 7,000 square miles "lying to the south and west of the longleaf region." The transition to longleaf pine land takes place where the Coast Plain passes into the Lignitic Belt—an example of a change in forest type corresponding, not with zones of rainfall, but with a change of geological formations, as the coast Neocene formation meets the Eocene sands of the Lignitic area. This inland half of the Coast Plain, the home of the loblolly, is characterized by a higher level and a more undulating surface than the seaward half. Its altitude is from 50 to 150 feet. Low ridges of sandy, loamy, open-textured soil interrupt the compact clays and silts, with intervening depressions which are more or less swampy in wet times, and broad, shallow streamways, presenting a large area of rich alluvial land.

Each of these conditions harbors its own peculiar association of species. The sandy ridges are covered normally with pure loblolly. The half-swampy flats grow a jungle of hardwood, with some loblolly, undergrowth, climbing vines, and often palmetto thickets, in which this species attains the unusual height of 10 or 12 feet, with a trunk rising 3 feet above the ground. In the alluvial valleys the characteristic hardwoods bottom forest is found, with a sprinkling of loblolly added. Oaks are especially abundant and of excellent growth throughout the area, except upon sandy knolls and ridges, where loblolly makes a pure stand. The forests of the loblolly belt are the densest in Texas, with a very thick undergrowth of shrubs and small shade-loving trees. The "Big Thicket" of Hardin County, famous as an almost impenetrable forest, is of this type.

The abundant loblolly pine is of greatest commercial value. In the tracts of pure forest a cut of 12,000 or 15,000 feet to the acre is not rare. On the alluvial soils it is of course of much less importance.

The heavy loblolly timber is being very rapidly marketed, mostly as yellow pine lumber. It is generally called shortleaf; the term loblolly, so far as the writer knows, is used only to indicate specimens with a large percentage of sapwood, such as occur in the swampy flats or draws in the longleaf belt. These are apparently supposed to be

simply a swamp growth of longleaf pine. In heavy mixed forest, loblolly is also culled for ties, along with much white and overcup oak.

The Galveston storm of September 9, 1900, destroyed a great amount of valuable loblolly. On many thousands of acres the forest was uprooted almost to the last tree. The whole forest area west of the Trinity was more or less damaged, and was left with so much débris as to render damage by fire a serious menace, besides making lumbering much more difficult.

FUTURE OF THE FOREST.

While reproduction after lumbering is good in this region as a whole, under the present methods logging in pure pine forest leaves very little prospect of renewal with the same growth. A succession of inferior forest, beginning with scrub oak, is the natural sequence. Into this the loblolly appears gradually to find its way back; probably in the course of time, if sufficient seed-bearing trees were left for it to start from, it would again gain the upper hand. Some of this forest has already been cleared to make way for sugar-cane fields, and it will doubtless be further curtailed for cane, rice, and other crops, and notably for fruit raising.

THE LONGLEAF FORESTS OF THE FAYETTE PRAIRIE.

AREA.

The longleaf pine area in Texas includes about 5,000 square miles of that fine body of Texas-Louisiana timber which is unique in its isolation far to the southwest of the main longleaf belt, east of the Mississippi. The Texas portion is shaped like a broad wedge thrust in between the loblolly at the south and the shortleaf at the north, and extends southwestward to the Trinity River, where the overlapping areas of loblolly and shortleaf form its western boundary. The longleaf forest nearly coincides with the Fayette Prairie formation east of the Trinity. The altitude here is greater than that of the loblolly belt, ranging from 100 to 300 feet, and the country is rougher and better drained, although the southern margin of the longleaf belt in Orange and Hardin counties, where it really overlaps the Coast Plain, is low and poorly drained. The typical longleaf country is one of sand ridges, offering an open soil texture to a relatively great depth, into which the long taproot of the pine thrusts itself so far as to be in great measure independent of surface conditions of soil and moisture. Such open, sandy soil dries rapidly near the surface—a fact to which the drought-enduring nature of those annual plants which have access only to surface moisture bears testimony.

The depressions between sand ridges are either poorly drained flats

or well-established drainage basins. In either case they offer soil conditions which permit hardwoods to penetrate into the longleaf forest.

CHARACTER OF THE FOREST.

Longleaf pine is characteristically found in heavy forest over large tracts with a practically pure stand. Especially is this true on sandy uplands, or the true pine barrens. This purity of stand, combined with the good quality of the timber, makes the longleaf forest both the most valuable and the most easily marketed timber resource of the State. The trees make a large and perfect growth, yielding logs of a maximum diameter of from 36 to 40 inches, with a clear length of 60 feet. From the high percentage of merchantable trees, lumbering, if conducted without restriction to secure a future supply, is likely to leave standing what would form, even if uninjured at the time of operations and properly protected subsequently, but a scanty basis for a perpetuation of the forest. In point of fact, along neither of these lines has it ordinarily received any care at all.

That longleaf tends to grow by itself is due, primarily, to the fact that it can flourish where most species can not live. On the dry sands, it finds a refuge from the competition which is generally too much for it on moister and better soils. In spite of its adaptation for seeking water far below the surface, it is a reasonably safe conclusion, in view of all the facts, that it grows where it does rather from necessity than preference. It is probable that if it were free to occupy better ground without having to fight for it the result would be either finer or faster grown timber, or both, than that which the tree now makes. But the first demand of the longleaf is for sunlight. With its long, clear stems, thin tops, and scanty undergrowth, its typical form is an open forest, and it can reproduce in no other. Such a tree has no choice but to withdraw to situations which other species do not care for. The result is that, after lumbering, the thickets of hardwoods (except for scrub oaks) which are so aggressive on cleared loblolly and shortleaf lands, are conspicuously absent. It is true that hardwood species do ultimately encroach on cleared longleaf lands, but the encroachment is very slow; for, as a rule, the new growth has to bring its own soil with it, by developing a humus to grow in.

Under present conditions the longleaf does absolutely nothing toward building up a humus soil, because of the recurrent fires which prevent any accumulation of leaf litter. Naturally a longleaf forest creates an excellent humus; but, growing as it does on sandy, well-drained soil, when the fires which always become frequent with the appearance of man begin, the organic material in the forest floor is soon lost. The result is to accentuate the condition which originally

determined the natural selection of forest growth on these areas, as the dry, poor soil, by the destruction of the moisture-holding and enriching humus, becomes still dryer and poorer. There is then still less to invite the encroachment of other species than there was before.

Frequent fires, however, though without marked effect on old longleaf trees, are fatal to the growth of seedlings. In consequence a condition is developed very like that which existed on the Texas prairies when the fires were free to sweep over them annually. These prairies were kept pure grass lands; there was no evidence of the thickets of chaparral which now cover them. The longleaf lands, instead of an under forest, have a pure prairie beneath the mature forest canopy, and this prairie becomes, after logging, a savanna of tall broom-sedge grasses. That fire is the chief cause of the absence of young growth to take the place of mature pine is shown by the circumstance that where for a series of years the fires fail to sweep, a thicket of young pine appears. These patches of "orchard pine" saplings or poles are frequently met with in the longleaf belt.

RATE OF LUMBERING AND FUTURE PROSPECTS.

The longleaf pine in Texas is being cut out at the rate of some three-quarters of a billion feet of lumber each year, with a rapidly growing market and output. The ease and cheapness with which longleaf is got to the sawmill, combined with a climate which permits heavy logging throughout the year, makes possible a very rapid handling of the crop. At the present rate of lumbering it would appear a reasonable estimate that the virgin pine might hold out twenty years longer.

With the present market demands and the prevailing methods of logging, the forest is so depleted and left in such a weakened and exposed condition that no future stand can be counted upon. But there is a good deal of longleaf land on which logging fifteen or twenty years ago, when the market demanded culled stock, left a very considerable amount of young timber and imperfect or inferior old trees. Such areas, however, are being lumbered again for ties, and thus their gain in wood is continually offset.

Longleaf seeds abundantly enough, yet there is very little seedling growth. This is entirely due to the regular and frequent fires. Neither young longleaf nor any other trees are able to start in the face of these. But wherever the fire has failed to sweep for a number of years, and the forest is sufficiently open, one finds thickets of young longleaf, the borders of which dwindle away in scattering, fire-stunted saplings, and a final border of young seedlings half hidden in grass which has escaped fire for a year or two.

HARDWOOD AND SHORTLEAF FORESTS OF THE LIGNITIC BELT.

EXTENT.

These are by far the most extensive of the east Texas forests. Of the pine timber there are some 30,000 square miles, but the forest type, with oaks forming the chief part of the mixture, covers a much larger territory, spreading over the whole of the Lignitic Belt to its western margin at the Black Prairie, and far southwestward into the Rio Grande Plain. The pine area lies between the longleaf and loblolly belts and the Red River, reaching westward to Hopkins and Anderson counties. Beyond this the pine drops out, perhaps because of the lessened rainfall, and the post oak region is entered. It is the writer's belief, however, that shortleaf pine can be made to flourish on most of the Lignitic formation westward to the Black Prairie, and that it has economic possibilities in connection with forest management for the entire region.

The shortleaf and post oak forests are found on the highest and roughest parts of the Tertiary plain which covers east Texas down to the Coast Plain. The shortleaf area begins in Houston and Angelina counties, at an altitude of over 300 feet. Its appearance is rather closely associated with that of the characteristic red clays found thence northward to Texarkana. This whole Tertiary plain, which includes the longleaf area, is a region of sand beds and underlying clays, an unconsolidated mass favorable to tree growth. It will be recalled that the region has already been described as the remnant of an ancient plain worn away by erosion, in which the streams have established wide drainage bottoms, with second bottoms or benches rising to the divides from 100 to 200 feet above the present stream level. It is on these uplands that the shortleaf and oak prevail. The alluvial bottom is covered by mixed hardwood forest.

COMPOSITION OF THE FOREST.

Aside from the shortleaf the upland oaks hold the lead. Of these the post oak is the most abundant and universal; after this, black jack and blue jack—the latter especially to the east. Besides these there are two upland hickories—the nutmeg hickory and the pignut. Many of the alluvial bottom species also, pushing up the slopes and following the innumerable small ravines and draws, penetrate into the upland forest at every point. Elm, white oak, red oak, and sweet gum are to be found well out upon the upland.

THE SHORTLEAF PINE.

The only important timber tree is the shortleaf. Of its total 30,000 square miles of area, however, only a small part is in the region of its



FIG. 1.—OPEN SHORLEAF PINE FOREST; HEAVY UNDERGROWTH OF YOUNG PINE, SCRUB OAK, ETC , ON UPLAND SANDY SOIL NEAR GARRISON.



FIG. 2.—SHORTLEAF PINE DEADENING NEAR GARRISON; A GOOD STAND OF LARGE POLES WITH MANY GOOD TREES DESTROYED TO MAKE A COTTON PATCH.

24

best development, which takes in, with northwestern Louisiana and southern Arkansas, the northeastern counties of Texas. In these counties a shortleaf forest of considerable extent originally stood. Of it Doctor Mohr wrote: "North of the Sabine River, from Longview through Cass and Bowie counties, the shortleaf pine forms compact forests over many hundreds of square miles."^a Most of this pine has been cut out.

On the vastly greater area where the pine is more or less diluted by hardwoods more remains standing. Much of it is too scattering to support an active lumber business, but patches of almost pure pine bring up the average. But despite the fact that most of the territory is on the border of the shortleaf pine belt, the noteworthy size of the individuals shows that the conditions are favorable for the growth of the tree. Veterans over 3 feet in diameter are frequent, and apparently reliable reports speak of trees with a diameter of 6 feet and more.

Shortleaf lumbering began earlier than that of longleaf and loblolly, because the first railroads cut through its territory. In 1880 the output of shortleaf was 146,420,000 feet, against 61,570,000 of longleaf. To-day it can hardly amount to one-tenth that of the longleaf. The very large mills, like those at Texarkana, do not depend to any great extent on the Texan supply. Smaller mills, with a daily capacity of 20,000 feet, more or less, are clearing up the lesser patches and the large trees scattered through the mixed forest along the lines of the railroad; but all the better bodies of pine have been logged.

In the pure pine forests very little promising timber was left standing, and the land was usually overrun by oak thicket. In the vicinity of Texarkana, however, a good cut of pine has recently been made on land logged over thirty-five or forty years ago, and in the northeastern counties there are rather frequent thickets of second growth, and a good deal of scattering pine saplings. Still the prevalence of scrubby oak forest everywhere gives the whole an unpromising look. In the mixed forest a heavy oak timber is already on hand to take the place of the pine. In every case, after the removal of the pine the forest is of small commercial value, capable of furnishing little but fuel and coarse construction material.

Left to itself, the forest reconquers its territory aggressively. Even the pine is a good ground-gainer here, and with a reasonable amount of assistance could be made a valuable resource on many an unpromising acre. But wherever there is a loamy soil, undoubtedly it is better cleared and put under cultivation. This is taking place even to the length of sacrificing some excellent patches of almost pure shortleaf (see Pl. II, fig. 2). Much of the inferior forest may very properly be

^a Timber Pines of the Southern United States. Bul. 13, Bureau of Forestry.

converted into fruit farms, a form of enterprise which is making substantial progress and seems to have a promising future. Nevertheless, even under agriculture the region will need a great deal of forest, though of this inferior quality, for protective purposes, both to conserve moisture and to prevent erosion, to which the soils are particularly susceptible.

THE POST OAK FOREST.

In the Lignitic Belt, as we have just seen, the upland timber from Hopkins County on the north and Anderson on the south (the western limit of the shortleaf) to the Black Prairie is mainly oak. This oak timber follows the southwesterly extension of the sands and gravels and clays of the Lignitic Belt far into the Rio Grande Plain—to the sand ridges about Carrizo Springs, for example. But isolated from the main belt are other extensive areas of this type of forest, which in general occurs westward to the one hundredth meridian wherever the geologic formation offers conditions similar to those in the Lignitic Belt—namely, pervious sand and gravel beds and sandy red clay hills. Thus the two areas of special note, the Upper and Lower Cross Timbers (see Map I), are of this type, as are also the open forests of the granite region, of the Carboniferous area, and of the isolated gravel terraces such as those above the Colorado River at Austin. In the Rio Grande Plain, however, although the favorable soil conditions continue, the post oak dwindles out a little beyond the Nueces, after having followed the Fayette Prairie formation from east Texas to this point.

The area of granite exposure, with the carboniferous limestone bordering it, and the main carboniferous area north of the granite, with the Upper Cross Timbers, give an almost continuous belt of post oak timber from Gillespie County to the Red River. The Lower Cross Timbers, running from the Red River to the Brazos, along the ninety-seventh meridian, together with numerous smaller tracts of scattered shore-line gravel beds, increase the area of post oak timber west of the ninety-seventh meridian to considerable proportions, and provide a vast quantity of useful, if inferior, construction material over an area in which it is most needed.

There is more to notice in this type than the mere absence of pine timber. Unlike the types previously described, it is a forest adjusted to arid conditions. It is, in fact, the type which the Atlantic forest assumes when it passes into the arid southwest. Naturally those areas of it which lie so far west as Llano, in central Texas, or Carrizo Springs, in the Rio Grande Plain, mark the extreme degree of change brought about by drought. It will be recalled that in the Lignitic Belt there were species of hickory, Spanish oak, and some of the alluvial bottom timber, besides much woody undergrowth, in addition to the pre-

dominant post oak. Westward not only the pine but most of these as well disappear, except on areas where the soil water is held available, as in the Cross Timbers and along the Pedernales at Fredericksburg. In general, in going westward not only is there a sifting of the moisture-requiring species until there remains only the one or two species of barren oak, but also these oaks themselves change their appearance. Instead of standing with their crowns in contact, they become isolated, with very short trunks and rounded crowns, so that the forest presents an open, park-like appearance, with a prairie-grass floor.

The post oak is not a timber of much commercial value—even less so the black jack. But since the former attains a rather large growth, there being quantities of it 15 to 24 inches in diameter, with a clear cut of 10 to 15 feet, it is available for certain large construction timber, and has especially been extensively used for ties. This, however, has been chiefly on new lines through post oak timber. As a fuel the post oak is a great source of supply, and lying, as it does, beyond the region of pine and other hardwoods, and in a region where fuel is extremely expensive, it is marketed in enormous quantities. The supply would seem to be inexhaustible. The post oak belt, where it is crossed by the Houston and Texas Central Railroad, reaches from Elgin almost to Brenham, a distance of 60 miles. On the International and Great Northern it begins at Rockland and extends to Neches, 230 miles, before the shortleaf pine begins noticeably.

In the writer's observation the post oak makes habitually an irregular, imperfect growth, and is very much affected by disease, especially by the infection of certain fungi which cause dry rot. To such an extent is this true that its value for fuel is very seriously impaired because of the doty wood.

Agriculture in the post oak country.

The part of the Lignitic Belt on which grows the post oak forest lying to the east and southeast of the Black Prairie—that is, the western part—has been brought more extensively into cultivation than the eastern, which has the shortleaf timber. This means, of course, that the oak timber has been or will be cleared from such tracts as have loamy soil, or any soil upon which cotton can be raised. The timber will very properly be restricted more and more to the poor soils; but its economic value ought to be improved in proportion to its restriction. Of course it performs the functions of soil protection and moisture conservation to a considerable degree, but this could be accomplished equally well by timber of better quality. It must be possible for shortleaf and loblolly pine to flourish over much of this region—certainly as far west as the tract of loblolly pine on the Colorado at Bastrop. With the increase in agricultural and related

activities, this will become a region in which timbered tracts will be maintained as adjuncts to farms, furnishing local fuel and construction supplies and at the same time protecting against soil erosion and deterioration. It will then be well worth while to try what the pine will do.

TIMBERED AREA OF THE EDWARDS PLATEAU AND OF HILLS AND
BLUFFS NORTHWARD FROM IT.

Next to the forest area of east Texas, this is the most important timbered region of the State. The Edwards Plateau is the rough, deeply eroded southern margin of the Great Plains, which end abruptly in this part of Texas at the vast fault line, or downthrow, known geologically as the Balcones Escarpment. This escarpment is very prominent along the southeast and south from Austin to San Antonio, and westward to the mouth of Devils River. The body of the plains in this region has been so deeply eroded as to present a picturesque mountainous country, with all the diversities arising from erosion and weathering of limestone strata of various degrees of hardness and differences of texture. Thus there are steep bluffs and deep gorges, isolated buttes, long, even slopes covered with talus débris, or flatter upland covered with coarse fragments of hard limestone boulders—the “hardscrabble” country. Again, there are small valleys and lower flats upon which a fair amount of rich soil has accumulated, thus offering limited agricultural opportunities. The area embraces perhaps 15,000 square miles, with considerable additions in the hills and bluffs along the streamways in north middle Texas, where similar physiographic conditions occur.

The region lies mostly to the west of the ninety-eighth meridian, and consequently in a rainfall zone of under 30 inches annually. This amount of rainfall, especially with its very irregular seasonal distribution, is too low to maintain a forest cover, except under conditions where the rock strata are broken up sufficiently to retain and give up gradually the precipitated moisture. It is interesting to note this close dependence of a certain type of vegetation upon a particular phase in the history of a geological formation. Thus, climatic conditions remaining the same, if the Edwards Plateau were an uneroded highland, its vegetation would, under natural conditions, be open grass prairie. As a matter of fact it is being cut down to the coast level as fast as erosion can do it, and coincident with this it is in process of transformation from a grass prairie to timberland. This transformation is being hastened by the interference of man. Both agriculture and grazing have operated to prevent the recurrence of prairie fires, which, so long as they were periodic, kept the field swept clean of woody vegetation. The grass thrived under this burning; seedlings of trees were killed. Again, both have resulted in breaking up the heavy sod cov-



FIG. 1.—DEADENED FIELD OF RIVER BOTTOM HARDWOODS NEAR GARRISON.



FIG. 2.—LIVE OAK ENCROACHING ON THE COAST PRAIRIE BETWEEN THE BRAZOS AND SAN BERNARD RIVERS IN BRAZORIA COUNTY.

44

ering which of itself operated effectually to keep out tree growth; agriculture, by turning under the sod and putting crops in its stead; grazing, by killing out the grass by overpasturing. The neglected field and the overpastured and trampled prairie then became an inviting territory for the invasion of weeds and of woody growth, which quickly establishes a thicket and gradually a heavy young timber covering.

It is not to be inferred that the whole Edwards Plateau is a continuous timberland. On the contrary there is a considerable amount of open grassland. Even more of it is covered with a scattered scrub timber, but there is enough real timber to warrant the classification of it as a timbered country. The aridity of the climate is such as to exclude any such thing as a dense forest, except, as we have seen, in the deep, sheltered, and watered canyons. The timber of the Edwards Plateau is not one of deep shade, and of course is not accompanied by all those plants and animals which love the cool twilight atmosphere of dense forests. It is a dry-climate forest. The growth is stunted, the wood dense and hard, the branches rigid, the foliage somber, the leaves small and stiff; the climate is written in every feature.

GEOGRAPHIC RELATIONS OF THE SPECIES.

The Edwards Plateau is a common meeting ground for species from the Atlantic forest belt, from the southern Rocky Mountains, and from the north Mexican highlands. Yet the timber vegetation contains a very considerable amount of species either limited to Texas or occurring chiefly there. The situation comes about in this way: Numbers of Atlantic species, in pushing along the Coast Plain southwestward, have encountered the more arid climate of the Southwest. Surviving, they have become permanently changed into new species in adapting themselves, though showing close kinship with the species from their ancestral region. This circumstance was noted by Engelmann in his early articles on Texas. He says:

* * * But shrubby species peculiar to that region represent the larger trees of the same or analogous genera of the more northern parts of the country. The stately walnuts of your [northeastern] forests are reduced to the low *Juglans nana* (*J. rupestris*), a shrub that bears nuts the size of a musket ball. In place of the mulberry of your river bottoms, we find there the small *Morus parvifolia* (*M. celtidifolia*) with leaves one-fourth the size. The fine hackberry (*Celtis occidentalis*), one of the largest trees on the fertile lands of our woods, is there represented by an allied genus, *Acanthoceltis* (*Celtis pallida*).

Of course wherever these species have passed on southwestward beyond Texas, as numbers have done, they can not be said to be peculiarly Texas species. Yet it must have been in the Texas region that the change from the ancestral species occurred.

The more prominent of these species are tabulated below:

<i>Texas species.</i>	<i>Atlantic species.</i>
Mountain cedar (<i>Sabina sabinoides</i>)	Red cedar (<i>Juniperus virginiana</i>).
Mexican walnut (<i>Juglans rupestris</i>)	Black walnut (<i>J. nigra</i>).
Mountain live oak (<i>Quercus fusiformis</i>)	Live oak (<i>Q. virginiana</i>).
Mountain Spanish oak (<i>Q. schneckii</i>)	Texas oak (<i>Q. texana</i>).
Mexican mulberry (<i>Morus celtidifolia</i>)	Red mulberry (<i>M. rubra</i>).
Texas redbud (<i>Cercis reniformis</i>)	Redbud (<i>C. canadensis</i>).
Texas buckeye (<i>Ungadia speciosa</i>)	Buckeye (<i>Aesculus</i> sp.).
Mexican persimmon (<i>Brayodendron texana</i>)	Persimmon (<i>Diospyros virginiana</i>).
Granjeno (<i>Celtis pallida</i>)	Hackberry (<i>Celtis</i> sp.).

The principal Rocky Mountain species represented in the Edwards Plateau timber are the piñon pine, probably the Rocky Mountain cedar, and four or five oaks, among which are Emory's oak, gray oak, and switch oak.

Of Mexican or southern species there are the madroña, frijolito, gum elastic, and lignum-vitæ.

THE CEDAR BRAKES.

The dense growths of cedar form the most characteristic feature of the vegetation of the Edwards Plateau, and constitute a valuable timber resource. They are found also, upon hills and bluffs offering similar conditions, northward and westward as far as the canyons and escarpment hills of the Staked Plains.^a

The data are not at hand to warrant even an approximate estimate of the area covered by cedar. The Colorado River brakes, one of the largest series, are almost continuous from Austin to the San Saba country; it is perhaps no exaggeration to estimate the area of these alone at 500 square miles.

A typical cedar brake is so dense as to be penetrable only with extreme difficulty. The trees stand thickly, and also branch profusely from near the ground. They are of stunted growth, but with wide-spreading, interlocking branches. Consequently they produce very rough, knotty sticks. In the lower brakes, on better soil, the growth is taller and clearer than where the conditions are less favorable, and yields sticks from 10 to 18 inches in diameter at the base and from 12 to 18 feet long. But the stands are so thick that they produce a great quantity of timber. Whole communities, like Austin, for example, are largely dependent upon the cedar for fuel, especially from September to March, and the consumption for this purpose far exceeds all other uses. Hundreds of thousands of sticks have also, for many years, been annually consumed for rail fences, posts,

^aThe Staked Plains cedar may be one of the western species which replace the mountain cedar west of the Pecos River.

telegraph and telephone poles, ties, house blocks, sills, and all manner of rough construction.

The cedar brakes have more than a commercial value. Cedar can grow on the most soilless limestone débris, and its wide, low branching and thick stand make it a close cover which collects soil, prevents washing, and holds back the water to a marked degree. It is also a strenuous ground holder and ground gainer. It comes up quickly after fire and cutting, and would soon renew itself everywhere were it not that steep hillsides, with loose friable limestone, wash too much to permit a new growth to start well. In Bell County a characteristic cedar brake has succeeded a stand of Texas mountain oak, having occupied the ground exclusively after the removal of the latter. Near Austin cedar brakes that were cut close twenty-five years ago are now being cleared a second time and are yielding a vast amount of fuel, although too young to furnish much split wood. (Pl. IV, fig. 1.) On the other hand, a very competent observer testifies that toward the southwest, in the more arid part of its range, the cedar recovers very slowly after clearing, and almost not at all after fire. Here it is succeeded by oaks.

A deplorable loss of cedar has taken place from brake fires. For half a century these have periodically occurred; areas which have not been burned over are the exception. Every old settler can tell of big fires which burned for days. In July, 1901, a very disastrous fire occurred near Marble Falls, in which about 600 acres of valuable cedar were destroyed.

OTHER HILL TIMBER.

In addition to the cedar, other species of the hill timber are constantly being drawn upon for fuel and the rough construction material in demand on ranches and farms. While this demand results in the denudation of many arid hills upon which timber growth will be reestablished only with great difficulty, on the whole the consumption is not keeping pace with the spread of the timber area. An interesting case in point is furnished by conditions along the line of the Austin and Northwestern Railway, between McNeil and Burnet. In the vicinity of the former town the country is being rapidly denuded of timber to furnish fuel for the limekilns. But immediately beyond this, large tracts of dense thicket exist where formerly were fields or pastures, and so on up the line it is manifest that the hill timber is encroaching rapidly upon the prairie. On the other hand, the areas being denuded are left in an exposed condition where erosion is imminent, and the soil accumulation of years may thus be suddenly lost.

To sum up, then, the timber of the Edwards Plateau is gaining ground, but is also losing possession of some of the steeper hillsides. Its immediate value consists in the amount of fuel and rough con-

struction stuff furnished, in which the cedar excels. Its greater and permanent value lies in its capacity to furnish protection, whereby soil can be collected in difficult situations; to prevent erosion from sudden bursts of rainfall; and to retain a large percentage of the rainfall instead of permitting it to run off in destructive floods.

THE LIVE OAK TIMBER BELT.

In Texas, as in the South Atlantic States, the live oak occurs on the Coast Plain. The live oak belt is particularly noticeably between the Brazos and the Nueces rivers. But there is also a north and south belt lying chiefly between the ninety-sixth and ninety-ninth meridians, where the occurrence of live oak is more or less constant. This belt includes a portion of the Edwards Plateau, in which the mountain form of the live oak occurs often in patches of pure forest. But in the agricultural areas of the Black and Grand prairies and in the lower debris soils of the granite country—e. g., southward from Llano—the live oak grows to its characteristic proportions, and while in no sense a considerable factor commercially, it is a most valuable tree for ornament, shade, and the production of woodlot material, in a region where without it farms and ranches are apt to appear desolate. In the coast country, however, the live oak is at its best. In Fort Bend, Brazoria, Wharton, and Matagorda counties it reaches splendid proportions. In the neighborhood of the immediate valley of the San Bernard this large growth formerly stood so close as to be literally live oak forest. The heaviest of this—at least so far as observed by the writer—has been deadened in breaking out cotton fields. The soil here is a very deep, black, waxy alluvial sediment. Along the Brazos, where the trees, though fewer, are even larger, the soil is a more porous, sandy alluvium. This large timber suffered irreparably from the Galveston hurricane of September 9, 1900. The veteran trees, 3 to 5 feet in diameter, were especially singled out for the fury of the storm.

The live oak of the Coast Plain westward, toward the Nueces—in Live Oak County, for instance—yields noticeably to the increasing aridity of the climate, becoming a more stunted open growth, although staunchly holding its own as to numbers. Throughout this belt the live oak is gaining ground. Formerly it was limited to strips along the rivers and “islands” in the prairie—that is, to minor drainage branches. At the present time it is rapidly spreading over the grass prairie. The conditions between the Brazos and San Bernard west of Columbia afford an excellent illustration of this. The low divide between these streams was, a generation ago, open prairie. Now, except for cotton fields, it is mostly woodland. A plantation home from which the town of Columbia could once be seen is now shut off from a view of more than a few hundred yards in any direction.



FIG. 1.—CEDAR BRAKE NEAR AUSTIN, WHICH HAS GROWN UP AFTER A CLEARING TWENTY-FIVE YEARS AGO.



FIG. 2.—THICK GROWTH OF SMALL MOUNTAIN OAK ON THE SIDE OF A DEEP GORGE IN THE EDWARDS PLATEAU COUNTRY NEAR AUSTIN.

Abstract

This encroachment of live oak shows how inadequate is the cultivation of that part of the coast country, and reflects the unfortunate industrial conditions which allow lands unsurpassed for depth and richness of soil to become relatively unproductive.

THE RIO GRANDE PLAIN CHAPARRAL.

To one who had known the Rio Grande country forty years ago it would never have occurred that this arid region could ever lay claim to being in any sense a wooded country. Yet at the present time the wooded area is vastly more extensive than the open prairie. The Rio Grande Plain is now as truly a forested belt as are the more easterly portions of the Atlantic Coast Plain, but its aridity has so stunted the growth of the species as to make shrubs of them. The result is the peculiar and characteristic chaparral, or pygmy forest.

The associated species are of totally different stock from those hitherto considered. In geographic affinity they are mostly Sonoran—warm-temperate or semitropical desert species. A few of them are really tropical. Of those which grow to valuable size, there are Texas ebony, huisache, Texas catsclaw, mesquite, retama, and green-bark acacia. These, it will be noted, are all members of the bean family. Four of these, and double that number of shrub species, are of the mimosa kinship, a noteworthy fact, inasmuch as species of this kinship form a conspicuous part of the vegetation in nearly all the large arid regions of the earth—Argentina and Chile, Central South Africa, Australia, the Mediterranean countries, Persia, and Arabia. This fact helps to give a comparative estimate of the cultural possibilities of the Rio Grande country. In the selection of species for planting one could cover a range of trees far wider than would be possible on the dry plains northward, including even hardy tropical or semitropical species.

Besides the chaparral—which for the most part consists of shrubby species, often not exceeding 4 or 5 feet in height—the streams of the Rio Grande plain have a considerable amount of timber characteristic of the prairie streams, already discussed as river-bottom timber of the prairie region, which, with the westward extension of the post oak and the live oak types, furnishes a very considerable amount of usable construction material and fuel. On the whole, the chaparral is a very serious evil from its tendency to lessen the capacity of the country as a cattle range.

The geographic relation of the Texas region to the Atlantic Coast Plain, to the northern prairies, the Great Plains, the Rocky Mountains, the Mexican plateau, and the Gulf tropical zone is such that its vegetation as a whole shows affinities with all these regions. One may not inaptly speak of Texas as the battle ground for supremacy of plant races. In considering the timber vegetation we have continually noted the

strenuous efforts of Atlantic species to push southwestward, even in the face of an arid climate. The spectacle of a counter invasion is presented in the case of the chaparral, which is a horde of Sonoran shrubby species pushing their vanguard even into the agricultural areas of the State.

THE MESQUITE.

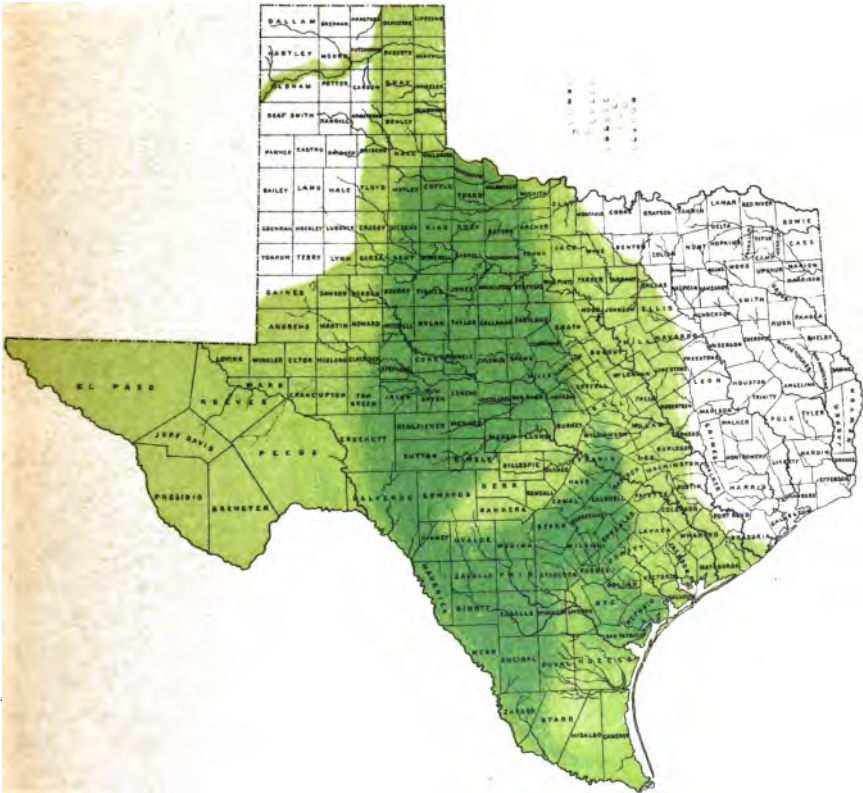
Among these the mesquite is the dominant and strenuous species. Its spread northward and eastward from the Rio Grande country during the past fifty years has been a marked phenomenon. By its invasion mile after mile of treeless plain and prairie have been won and reduced to the characteristic orchard-like landscape. In the coast country, and likewise in the Black Prairie region, it has passed the Brazos. It has pushed northward over the Staked Plains, covering half their area. Along their eastern front it has passed over Oklahoma and into southwest Kansas. Miles of the level prairie in the Abilene country are covered by mesquite. Large areas of the fine compact soils of the granite country harbor it. San Antonio is half surrounded by a "mesquite forest." Pastures about Austin are growing up in mesquite. The name "mesquite flats" points to the preference of this tree for low or level areas with fine compact soils, by which preference it avoids competition with native woody species, which are on rougher ground and more open, porous soils.

The coming of the mesquite has brought a vast deal of wood and much forage, but the agricultural areas do not need these at the price, and more arid areas would be better off in the long run in open grass pastures. Where mesquite is accompanied by prickly pear or other thorny species, as it is to the southeast of San Antonio, it becomes a serious menace to grazing interests and a heavy expense to farmers.

This encroachment of mesquite is partially accounted for by its weed-like capacity for occupying new ground, its preference for the flat country and compact soils characteristic of the grass prairies, the weakened condition of the grass covering due to overpasturing, which handicaps it in its efforts to maintain pure grass prairies, and by the influence of cattle in scattering the beans.

THE TIMBER OF THE CORDILLERAN REGION IN TEXAS.

This region is a part of the South Plateau of the Rocky Mountains. The more or less disconnected and isolated mountain masses which rise above it frequently exceed 6,000 or 7,000 feet, and in the Guadalupe reach 9,500 feet. The region lies in an extremely arid belt, but its altitude not only reduces the annual temperature but also notably increases the rainfall, which by virtue of the broken and tilted strata is retained to be doled out continuously, thus giving a measure of constant moisture which permits timber growth. Of this timber growth two types may be distinguished: (1) That of the foothills and slopes



DISTRIBUTION OF MESQUITE (*PROSOPIS GLANDULOSA*) IN TEXAS.

below 5,000 or 6,000 feet, which is a desert type; and (2) the timber of the high summits and the upper watered canyons, which belongs to the Rocky Mountain type. •

THE TIMBER OF THE FOOTHILLS AND SLOPES.

This type is analogous to that of the Edwards Plateau, and includes some of its species. The chief species are different, however, and belong to higher altitudes. The piñon pine is the most generally distributed, occurring upon the slopes of the Guadalupe, Davis, Chisos, and Organ mountains, and also on the higher ridges and bluffs of the Great Bend country, from the Southern Pacific Railroad to the Rio Grande. "In the Chisos Mountains, which it occupies exclusively, it becomes a straight tree with a trunk a foot in diameter, and could be sawn into useful lumber of fair quality. * * * It reaches about the same proportions in the Davis and Organ mountains."^a With the piñon pine occur western cedar, thickbark cedar, Emory oak, and one or two other oaks, besides shrubby and otherwise insignificant species.

THE TIMBER OF THE SUMMITS AND HIGH CANYONS.

This type consists of isolated islands of Rocky Mountain forest, whose principal species are yellow or bull pine, red fir, and limber pine, with Emory oak and gray oak of the previous type but making larger growth. This timber is limited to the Guadalupe, Davis, and Chisos mountains. The yellow pine and the red fir attain, for them, relatively small dimensions. The yellow pine grows to be from 1 to 2 feet in diameter and from 30 to 50 feet tall, "yielding [in the Davis Mountains] clear lumber 18 inches wide" (Havard). Second to it in size and quantity is the red fir. Of the oaks, the Emory oak becomes the largest tree. To quote from Havard: "On the El Paso road, where it skirts the southern base of the [Davis] mountains, this stately oak becomes the main feature of the sylvia; its straight trunk is from 2 to 4 feet in diameter, while its mass of shining foliage reaches the height of 60 feet."

This timber of the foothills and mountains constitutes something of a resource for mining operations, if it should prove to be available for them. In the development of the cinnabar mines in Brewster County the greatest lack is fuel, of which the only considerable supply is in the Chisos Mountains.

About Fort Davis most of the available pine was sawed while that was still a military post. The timber in the Guadalupe is said to be practically inaccessible and only usable upon the ground. In their capacity of protection these timbered slopes and canyons assist in maintaining several streams of good flow, whose waters are invaluable for irrigation and for watering range cattle.

^aHavard, Report on the Botany of Southern and Western Texas, 1885.

FOREST MANAGEMENT.

The State of Texas, with a merchantable forest that covers only 10 per cent of its entire area, cuts nearly a billion board feet of lumber a year. The lumber industry is exceeded only by the cotton and cattle industries. But of its comparatively small area of timberland 125,000 acres are cut annually, and cut in such a way that the land will not grow valuable forests again. Other timberlands, valueless for lumber, but of the first importance as a protection for agriculture and as a source of water supply, are burned and destroyed without regard for their great usefulness. Under present methods the exhaustion of a great economic resource is taking place, and conditions affecting the prosperity of wide areas are rapidly changing for the worse, while the public interest in the most effective utilization of the potential wealth of the State as a whole remains unprotected.

The alternative is forest management. The State needs extensive forests which shall be both permanent and productive. It can not afford to follow the method of prohibiting all cutting on reserved forest areas, as the State of New York has done. The products of the forest are at least as important to the State as the forests themselves. Not that all areas now under forest ought to remain woodland; clearing for agriculture is to be welcomed wherever agriculture will pay, and farms will ultimately occupy much of the country now under timber. On the other hand, forest extension may be expected to add other areas, now valueless for any purpose, to the list of woodlands. But whatever changes may take place in the extent and the location of its forests, it devolves upon the State of Texas to see to it that the forests which it needs are preserved. The means to this is forest management, or the practice of forestry, either by private owners or the State, or both.

Forestry in Texas should aim at the following ends:

(1) To discover and introduce lumbering methods which will provide for a future crop at a reasonable cost.

(2) To devise economical fire protection for cut-over lands.

(3) To prevent the destruction of forest growth which is needed to protect streams.

(4) To promote the maintenance of woodlots in connection with farms by spreading information concerning their care and usefulness.

(5) To plant trees in regions where there is now no forest growth, but where it can be usefully introduced.

Toward the first and second of these ends notable progress has lately been made as a result of the action of private owners, under the advice of the Bureau of Forestry of the U. S. Department of Agriculture.

It is a matter of congratulation that by far the largest owner of



FIG. 1.—CHARACTERISTIC VIEW OF THE TIMBER, MOSTLY MOUNTAIN CEDAR, ON THE EDWARDS PLATEAU, 20 MILES NORTHWEST OF AUSTIN.

U
S
D
E
P
O
F
A
G
R
I
C
U
L
T
U
R
E



FIG. 2.—TYPICAL POST OAK FOREST OF THE GRANITE COUNTRY IN LLANO COUNTY, LOOKING ACROSS FAIRLANDS VALLEY FROM GRANITE MOUNTAIN.

4

timber lands in the State, controlling perhaps 80 per cent of the virgin longleaf pine forest, besides much cut-over land, is preparing to introduce conservative forest management. The success of this plan will be nothing short of revolutionary in its effect upon the Texas lumber industry. When it can be shown to the private owner that it pays better to utilize the forest as a permanent source of supply than to destroy it, the public and the private interest in the forest become identical, and the future of the lumber industry is assured.

THE PROSPECTS OF PRIVATE MANAGEMENT IN TEXAS.

Two facts stand out in a consideration of the forest resources of Texas and the forces now in operation which affect them: (1) That at present the forests are being rapidly and dangerously diminished; and (2) that there is a good opening to check their exhaustion, if the proper steps are taken to that end.

The main hope of forest preservation lies in private management, Ninety-five per cent of the timberland of the State is already private property. The possibilities of private management are along the lines (1) of commercial forests to supply the market, and (2) of woodlots on farms to supply local needs and (to some extent) protection.

CONSERVATIVE LUMBERING ON VIRGIN TRACTS OF VALUABLE COMMERCIAL TIMBER.

The forests which supply commercially valuable timber are the longleaf, shortleaf, and loblolly pine forests, and the mixed hardwood forests of alluvial bottoms, embracing the best of the east Texas timber region.

CONSERVATIVE LUMBERING IN THE LONGLEAF PINE FOREST.

The longleaf pine forests now furnish four-fifths of all the pine which reaches the Texas market. Yet the longleaf pine area is relatively very small, and is rapidly diminishing. It was estimated by Doctor Mohr^a to have been originally 5,000 square miles—approximately 3,000,000 acres—with a stand of presumably some 30 billion board feet of lumber. But lumbering has been going on for twenty-five years, and on a large scale for fifteen years. The yearly cut has exceeded half a billion board feet since 1895; in 1900 it was at least three-quarters of a billion feet. Probably half the area has been cut over; fifteen years more of virgin timber cutting at a rate of a billion feet a year would complete the harvest. There would then be left only what has matured since cutting began. As a matter of fact some tracts are already being cut a second time. This is possible because in

^aTimber Pines of the Southern United States.

the earliest cutting only the finest trees were culled; enough was left to furnish, after a growth of from twelve to twenty years, a forest which now invites the lumberman's return. But there is at present a market for anything that will square 4 or 5 inches. The result is so close a cutting that nothing is left which can mature another crop inside of fifty or seventy-five years; indeed, in very many instances, the forest is practically destroyed. (Pl. VI.)

The renewal of the forest is made impossible by the agencies which prevent the growth of seedlings. The worst of these is fire. Fires are invited, and their destructiveness is very greatly increased, by the great quantities of waste left after logging. Often they are regularly set by cattle owners to improve the range. But for them, in the wake of lumbering, great quantities of seedlings would quickly spring up. Seed is produced in great abundance every three or four years. The seeds are widely distributed, and germinate prolifically. Wherever fire has been kept away, thickets of seedlings, saplings, and poles show what would be the general condition if the forests were protected against its great enemy.

Permanent management of Texas longleaf pine forests is impossible without both a reform in lumbering methods and effective fire prevention. The harm done by forest fires is so little appreciated, and methods of preventing them are so little understood, that it is doubtful whether general fire protection by private owners can be expected. It is for the State to consider whether some form of fire protection at public expense is not called for by the interest of the community at large, in forests as it is in cities. Assuming, however, that fire protection is impracticable, what can be done in the way of conservative lumbering? A plan looking only to a second or third cutting might disregard the matter of seedlings; the small timber now on the ground, which would mature within from twenty to fifty years, would furnish the crops. It should be a matter of concern to every owner of longleaf pine timberland in Texas to determine whether it would not be a wise business policy for him to cut no sound pine below a certain diameter limit. Many tracts lumbered fifteen to twenty years ago, when few trees below 18 inches in diameter were taken, are now being lumbered for large cuts of pine. Judging from these, no great change in the limit to which trees are now cut would have to be made in order to leave the basis for a second crop of timber from lumbered lands within a reasonable time. The Bureau of Forestry has just completed a field study of extensive longleaf pine lands in Texas, the results of which should show the financial returns to be expected from the conservative lumbering of longleaf.

The policy indicated would require the modification of present lumbering methods, and would prevent the destruction of small trees in removing the large ones. The expense of lumbering would thereby

be slightly increased, but at an ultimate gain which would more than justify the outlay.

More serious in the eyes of owners are likely to be the objections that there is a present market for practically all of the timber, which if left will be exposed to loss by fire, wind, theft, and disease; that money would be tied up in growing timber for a long term of years; that tramways would have to be provided for each cutting at great expense; that meantime taxes would be eating up the profit.

On the other hand, it is to be said:

(1) That while small timber is salable, the profit on timber squaring over 8 or 10 inches is so much greater that to cut it earlier involves a wasteful loss.

(2) That the price of high-grade lumber will probably increase very materially during the next fifteen or twenty years. This is indicated by the rapidly decreasing supply of pine timber in eastern North America with an increasing demand; by the history of the price of white pine; by the steady upward trend of southern pine during the past decade; and by the rapid exhaustion of longleaf pine in Texas now actually in progress.

(3) That with agricultural and industrial development the land itself is rising in value.

(4) That large lumber companies, organized to do business for long periods, are in the field with complete outfits, which they are constantly transferring from one tract to another. Their trams are all the time being laid, taken up, and relaid. They are equipped with everything needful for economical lumbering on a large scale. The one formidable danger which they have to face is that they may be left without trees to cut. The strong probability is, not that the owner of a good forest will have trouble in getting his timber to market, but that invested capital will have trouble in finding forests to occupy the plants on the continuous operation of which its profits depend.

CONSERVATIVE LUMBERING IN SHORLEAF PINE FORESTS.

Of pure shortleaf forest not enough remains uncut to make the question of conservative management important. Of mixed pine and upland oak forest there is yet a fair amount untouched, but its value is not great enough to support lumbering on the scale practiced in the longleaf forest. It is really an area of small operations, and the only opening for an application of principles of forestry is to conduct the lumbering in such a way as to permit the young pine now standing to develop, and, so far as possible, to favor pine in the reproduction. The forests of this region will find their chief usefulness as protective forests and woodlots.

CONSERVATIVE LUMBERING IN LOBLOLLY PINE FORESTS.

It will be recalled that the loblolly area is one chiefly of mixed pine and hardwoods, that it is the most densely forested area in the State, and that the coast country, which it occupies, is low and flat—a vast alluvial plain.

Although forest renewal is extremely aggressive, the value of the land for rice farms, sugar plantations, and other agricultural uses is such that, with the influx of settlers, the greater part of it will be brought under cultivation and the forests will be left to occupy only the less valuable tracts. Upon these, valuable commercial timber can be produced under management.

CONSERVATIVE LUMBERING IN THE HARDWOOD FORESTS OF ALLUVIAL BOTTOMS.

River bottomlands in east Texas are in too great demand for agricultural purposes to afford any prospect of permanent management by private owners beyond the supply of local needs by woodlots. Immigration is setting in at a rate that will result in the rapid clearing of the land; in many cases the forest is being destroyed simply to make way for farms. (See Pl. III, fig. 1.) The present stand contains vast quantities of superior hardwoods, and offers an excellent opening for large lumbering concerns.

It would be decidedly to the advantage both of the present owners, who have now no adequate market for their timberlands, and of the public, which would be benefited by the utilization of this valuable timber resource, if the capital necessary to harvest the crop could be induced to enter this somewhat neglected field; and it is to be hoped that better information of its amount, location, and value may be spread abroad. But the best eventual use for most of the land is plainly the production of field crops, except where the forest is needed for protection against erosion and to safeguard the water supply, and its preservation for the latter purposes should come not from private but from State action.

CONSERVATIVE MANAGEMENT OF WOODLOTS.

The application of certain principles of forest management on a small scale by farmers and ranchmen has large possibilities of usefulness, both public and private. The field for this is a very different one from that open to large concerns organized for the management of extensive forests. The latter can operate permanently only where great tracts of timberland exist which can not profitably be farmed. But even in the most fertile regions it is seldom that a farm contains no patch, large or small, which could not profitably be kept as a



FIG. 1.—LONGLEAF PINE LAND OVER EIGHT YEARS AFTER LOGGING; LITTLE OR NO
PROGRESS TOWARD REFORESTATION ON ACCOUNT OF FIRES AND GRAZING



FIG. 2.—LONGLEAF PINE LAND IN JASPER COUNTY IMMEDIATELY AFTER LOGGING
OPERATIONS, SHOWING WASTE AND DÉBRIS, AND THE AMOUNT AND CONDITION
OF TIMBER REMAINING UNCUT.



woodlot, and in the great majority of cases there is some hill or slope or ravine where timber growth would furnish valuable protection against soil erosion.

The advantage to the farmer of raising his own timber and fuel supplies is, as a rule, as self-evident as that of raising his own meat and vegetables in addition to staple crops. In the Lignitic Belt, in hilly central Texas, and along the streams of the central prairie region, the welfare of the community as a whole positively demands that a large percentage of timber growth be permanently maintained. This end could be secured if every farmer and ranchman would preserve the timber covering on the land he could well spare from cultivation. And the preservation of the timber is entirely compatible with its productive utilization by the owner *if a proper plan of management is adopted*. But the latter condition is just as essential in the case of the small owner as for the management of large forests in the pine country.

In many localities—in the case of cedar and pine lands, and on river-bottom farms where large oaks, ash, hickories, walnut, and the like now occur—the farm timber tract is capable of being made to yield still larger returns by the production of marketable timber.

FOREST EXTENSION.

The preservation of timber on areas where it occurs naturally requires little consideration of what species are to be raised or how to plant them. The establishment of tree growth on land not naturally timbered is a very different matter. In the former case nature has already furnished the answer to the question what kinds of trees will flourish; man has only to select. In the latter case the conditions must be carefully studied, and oftentimes painstaking experiments must be carried on with trees introduced from other and perhaps distant regions, to discover the right kinds and the way to make them grow.

The great diversity of climatic conditions in Texas presents very different problems in different parts of the State. The two chief factors in these problems are moisture and temperature. The absence of timber is due primarily to lack of rainfall. This is true of the Red Beds, the Staked Plains, the lower Rio Grande Plain (i. e., the Coast Prairie west of the ninety-eighth meridian), and, in general, all of Texas west of this meridian. In all these regions irrigation would be necessary at least part of the time. East of the ninety-eighth meridian there are large areas of treeless prairie with an annual rainfall sufficient to support certain kinds of trees. Such are the Grand Prairie, the Black Prairie, and the Coast Prairie east of the ninety-seventh meridian.

This region is capable of supporting a large and varied timber growth. The possibilities of tree growth in the Black Prairie, and particularly in the Coast Prairie country from Victoria eastward, are far greater than is generally believed, and the introduction of exotics which flourish under similar climatic conditions elsewhere will eventually furnish material additions both to the beauty and to the economic resources of the region.

In the region west of the ninety-eighth meridian the prospect is not so good. On the Staked Plains and in the lower Rio Grande country, where wells furnish the water supply, the limit of plantations will be set by the expense of raising and distributing the water. But on the plains only those trees can grow which are sufficiently hardy to endure a temperature of 10° to 20° below zero, while in the lower Rio Grande country the list of possible trees includes practically all which can grow in northern Florida, the San Joaquin Valley in California, and many of the lands which surround the Mediterranean.

CONCLUSIONS CONCERNING PRIVATE MANAGEMENT.

It is plain from the survey of the prospects of private management of forests in Texas that, in spite of conditions favorable to its practice in many parts of the State, and in spite of the hopeful beginning which has already been made toward introducing it in the longleaf pine territory, unaided private initiative will not suffice to protect the public interests affected by forest destruction. Under the lumbering methods now employed the pine forests are either ruined or so severely injured that their productiveness is greatly impaired. On the longleaf pine lands reforestation under present conditions is practically impossible. On loblolly and shortleaf lands reforestation is rapid enough, but the pine is for the most part replaced by scrub oak thicket. Fires and taxes remove the inducement to the forest owner to cut with reference to subsequent crops. The owners of small tracts and woodlots lack the knowledge required to make the most of their holdings. Communities dependent on the maintenance of forest cover for their water supply, or for protection against floods and silt, are exposed to the consequences of deforestation by landowners at a distance, acting solely with reference to their own interests. Left to themselves, the forces now at work will result in an impoverishment of the resources of the State which it will soon be too late to prevent, and will produce conditions necessitating remedial measures at very heavy public expense.

FOREST MANAGEMENT AND THE STATE.

State action to protect its forests may be (1) by promoting management by private owners, and (2) by itself undertaking the management of forests on State lands.

PROMOTION OF PRIVATE MANAGEMENT.

The main difficulties in the way of the introduction of private management on an extensive scale and in all parts of the State where forests of commercial value grow, are:

(1) *Protection against fire.*—This is of special importance in the longleaf belt, the chief seat of the lumber industry of the State. At present the renewal of the forest is made impossible by the fires which periodically burn the forest grass and litter and destroy the seedlings. But protection is difficult for the private owner, who is exposed not only to fires originating on his own tract, but also to those which invade it from his neighbor's lands. To maintain an efficient fire-fighting force would usually involve a prohibitive expense. It is possible that something might be done in the way of fire protection by the organization of State fire wardens or a forest patrol, particularly if the expense could be reduced by employing local officials already intrusted with other duties. But the only really effective way of controlling fires is to keep them from starting. The forests do not begin to burn up of themselves. While it is true that lightning has been known to originate forest fires, the proportion of fires from natural causes is so small as to be negligible. It is from those of human agency that the forest needs protection. To secure this a strong, enlightened public sentiment is needed. In a community which regarded setting fire to a man's woods as seriously as setting fire to his barns the problem of fire protection would be reduced to insignificant proportions. There is no more important work for the State to do in protecting its forests than to educate public opinion in the matter of fires.

(2) *Taxation.*—Forest management, which involves holding cut-over lands for a long term of years without return, is impossible in the face of high taxes. To tax forest lands on the same principle as agricultural land is simply to put a premium on destructive lumbering. Even if the valuation is put low enough not to be in itself inequitable, the necessity of paying taxes annually on land recently cut over, which will yield no revenue as timberland for many years, is a discouragement to all holders not possessed of large capital. Taxation based on the value of the standing timber, or taxation of the crop when harvested, would be at once more wise and more just than a tax levied at a constant annual rate.

(3) *Theft.*—The same unfortunate sentiment which permits setting fire to forests operates also as a source of loss to the owner by a more

or less sporadic cutting of timber without his consent. The pine lands of Texas are not unique in this respect, but here as elsewhere has harbored that unfortunate type of woods dweller who feels that he has an inalienable right to depredate upon the forest property of the larger, and especially the nonresident, owner. Here, again, it seems more a question of developing an enlightened conscience and a disapproving public sentiment than of combating a positive criminal tendency, but it must be understood that a man's forest property has the same protection against the trespasser and depredator as has his immediate residence property.

(4) *Losses by disease and injurious insects.*—At present the loss of timber from "red heart"—a fungous disease—is a very serious matter for the timber owner. Scientific investigations into the causes of damage to timber, and of possible preventive measures, may effect a great saving and proportionately stimulate private management by increasing the yield. Such investigations are for the public benefit, and may well be undertaken at public expense. It is not to be expected that the private owner will undertake them for the public good.

WHAT THE STATE CAN DO FOR PRIVATE MANAGEMENT.

The State can further the practice of forest management by private owners by (a) legislation, (b) education, (c) police protection, (d) investigation of forest problems.

(a) The taxation of forest lands, timber stealing, and forest fires should be considered with reference to existing laws and the possibility of improving conditions by their modification or by the addition of new laws.

(b) Information concerning paying methods of management should be diffused, public interest in the preservation of the forest as an economic resource should be awakened, and a healthy sentiment concerning the necessity of care to prevent fires should be built up.

(c) Proper officers should be charged with the definite duty of detecting and punishing those who steal, or wantonly, maliciously, or for their own advantage injure or destroy timber, and the most efficient protection possible should be devised for this form of property.

(d) It is worth considering what the State can do to secure, either through experiment stations or by cooperation with institutions capable of conducting the necessary researches, or with the aid of the Bureau of Forestry of the U. S. Department of Agriculture, scientific study of such questions connected with forestry as are likely to yield valuable practical results.

To devise and direct a permanent policy along the lines suggested, the establishment of a State forest board or commission would be desirable.



FIG. 1.—TYPICAL SWAMP FOREST ALONG THE NECHES RIVER NEAR BEAUMONT;



FIG. 2.—TYPICAL FOREST OF MIXED LOBLOLLY PINE AND HARDWOODS IN THE MARITIME BELT; WESTERN EDGE OF THE "BIG THICKET" COUNTRY IN LIBERTY COUNTY.

44

STATE MANAGEMENT.

The original State timberlands would have sufficed for a policy of State management on a large scale. Even after the various railway grants this might have been the case. But it has been the policy of the State to hold these lands available for purchase on mild conditions, so that when the yellow pine in particular found a wide market at good prices the State pine lands were in much demand. Either the land or the stumpage was sold. The greater part of the pine land now held by the State is cut-over land. During the past five years this also has been in demand, until the total has been reduced to an acreage too small and too scattering to make State management possible. This would now involve the acquisition by purchase or otherwise of additional lands. The same would be equally true of the shortleaf area and the Edwards Plateau. In all of these regions the topographic and soil conditions are such as to render imperative the maintenance by some agency of protective forests for the benefit of agricultural and other interests. The best argument for State management lies in this need of protective forests.

PROTECTIVE FORESTS IN THE LONGLEAF PINE BELT.

In parts of the east Texas region the retention of the pine forests is threatened by the sale of the land for farms. It is open to question whether agriculture can permanently succeed here; since it has failed on similar land in the Carolinas, which has been found too sandy and barren for crops.^a Immigration into the region is taking place at a rapid rate, assisted greatly by the oil boom and the demand for labor created by lumbering. The past two years have witnessed an influx of settlers literally by the car load. The rapid development of the country in this direction, together with the possibility of extending the present known area of oil production, has created a demand for the cut-over lands such that already some hundreds of thousands of acres have been bought up by large concerns or by individuals. Cut-over State lands, which were about the only timberlands left to its ownership in this district, have been included in these purchases. The State's interest as an owner is therefore not of great moment. The

^a The Bureau of Forestry is cooperating with the Houston Oil Company in the preparation of a working plan for the management of their timberlands, one of the objects of which is to outline a scheme of lumbering which will provide for the preservation of younger trees until all that now occupy the ground are large enough for high-grade lumber. If with State cooperation, an effective system of fire prevention can be carried out, of course the renewal of the forest from seedlings will be assured, and thus the continued productivity of the forest will be made possible. With this sort of cooperation between the State and private owners or corporations, the larger part of the longleaf pine lands might be kept as permanent commercial forests.

trend of land speculation at the moment is to transform these pine lands into farms and orchards and, where oil is indicated, into oil fields. If these circumstances continue there might seem to be little opening for forestry, the purpose of which is not to substitute a worse crop for a better one, but to secure the best use of all kinds of land. Not until it has been definitely established that the region is an agricultural one can this be decided.

Even if this is true, however, the dependence of the agricultural interests on the retention of a certain amount of forest growth in this region furnishes reasons for not abandoning the forest altogether to the play of the private interests directly concerned. It is a very serious question whether in the long run it would not be found to be a mistake to transform pine barrens as a whole into farm lands. There can be no doubt that the retention of forests on the rougher, poorer land would prevent deterioration of the better tracts by erosion and by the lessening of the water supply consequent upon a general removal of the forest.

It has been suggested in somewhat similar connections that perhaps sufficient protection would be afforded by the practice among private owners of reserving woodlots or larger timber tracts upon the poorer ridges or barrens. It will in any case be many years before the land is denuded of forest growth, and before the effects of forest removal will be felt upon agricultural operations. Meanwhile there is time for a campaign of education which would interest private owners in the rational practice of forestry on their own lands, at least so far as to protect their farms and raise their own timber supply.

There is, however, another point of view, which is that the State should by utilizing its present holdings, and by actual purchase of other tracts, establish a forest reserve in the longleaf pine area. Sound arguments for this course would seem to lie in the following considerations:

(1) This longleaf area is capable of producing a continuous supply of high-grade timber, on the margin of a vast territory practically incapable of growing timber supplies of high grade.

(2) A considerable proportion of the area is scarcely suited to the *continuous* production of anything except timber.

(3) The better tracts, which would include especially alluvial bottomlands, would be benefited by the retention of forests on the poorer ones, especially upon the upland sand barrens.

(4) The welfare of the community in the long run, subserved by retaining this valuable forest land, would offset the objection to the State's acquiring at considerable expense temporarily nonproductive land. Omitting the views of private holders immediately concerned, it is believed that the people of the State would be unanimous in their desire to see the longleaf pine area a permanent forest. This is not

to say that they would at this time indorse a proposition for the State to purchase and apply forest management upon such lands. That would mean such a radical departure from precedent and tradition in the State's activities as doubtless to encounter strong opposition.

(5) If the State should turn buyer and acquire pine lands enough to establish a forest reserve, it could place these lands under a well-devised plan of business management which would in a reasonably brief time be brought to a revenue-yielding basis. This would certainly be the case on those tracts where lumbering operations had left a fair stand of young timber. Such a course of management successfully carried out would be a most valuable object lesson to private owners, large and small, and might be expected to result in such an introduction of practical forestry on a large or small scale as would give the region a far greater value than would result from either an all-farm or an all-forest condition.

PROTECTIVE FORESTS ON THE EDWARDS PLATEAU.

Both the welfare of the Edwards Plateau itself and the welfare of the Coast Plain adjacent to it strongly demand the retention of a permanent timber covering on the plateau.

The relation of the Edwards Plateau to the Coast Plain between the Colorado and Devils rivers is like that of the Sierras to the valleys of central California, and of the Rocky Mountains to the adjacent plains in Colorado. Kings River and the San Joaquin River in California find their counterparts in the Guadalupe, San Antonio, and other rivers rising in the Edwards Plateau. In both cases the highlands furnish the water—in the former from snows, in the latter from springs. In both cases this water is both a boon and a menace to the country below. It is beneficial or destructive according to the rate at which it runs off the hills. Nature has placed a great reservoir high above the irrigated farms. The water is held back and distributed in even flow, not from a lake, but from the face of the country itself. On the Edwards Plateau the rock strata, exposed by erosion and dislocated by faulting, normally take up the water, which then percolates slowly to feed the steady-flowing streams. But to make this possible there must be a soil covering to hold the water when it falls. The plateau is a deeply cut up, mountainous area, with canyon-like valleys and highlands, thinly covered with soil. The rain comes in sudden cloudbursts, which, if not held back by forest growth, pours rapidly from the hillsides, carrying down soil and stones, and rushes off in destructive floods to inundate great areas of farm land below. The region is that of the arid Southwest, where agriculture without irrigation is uncertain. Destruction of the forest cover does not take away the reservoir; it opens the gates to pour the water down in successive inundations, instead of holding it in check until it is needed.

These hills, stripped of forest cover, become arid and worthless. On the sides and slopes of deep gorges which are heavily wooded there is found a deep accumulation of leafy humus. The cedar brakes also collect and hold large quantities of *débris*, and thus provide a covering several inches deep over the rocks. After the removal of the timber all this is rapidly washed away, and the restoration of the forest growth becomes impossible. Kept under timber, the land can be made to furnish a vast amount of material for posts, poles, ties, and rough construction purposes, as well as cheap fuel in a region where coal is very expensive. Yet there is little hope that the owners will preserve the forests. Small holdings are cut for the sake of the immediate profit. Large holdings are used chiefly as pasture lands, and the grasses flourish better without the timber. The country is primarily a cattle country, and cattlemen are apt to regard the timber as a nuisance rather than a benefit. All of the available timber is being cut as rapidly as it can be sold; in consequence, the steeper hillsides have become so denuded that natural reforestation seems impossible.

Manifestly this area needs a close covering. Fortunately, the forest type native to it is both dense and an energetic ground gainer. Many miles of old, stony pasture are growing up into thickets of live oak, cedar, elm, mountain oak, and shin oak; and on hills in Bell County and elsewhere from which a thick growth of mountain oak has been cut, an equally thick growth of cedar is taking its place. Timber tracts in the vicinity of Austin which were denuded twenty-five years ago are now heavily forested with cedar, which is again being cut, although immature. (Pl. IV.)

A forest policy which would recognize both the welfare of the hill country and its economic relation to the Coast Plain could be carried out only by the State. This would involve the purchase and reservation of timber tracts. But the price of the land which ought to be forest reserve is so low, and its value for any other purpose is so small, that the expense of such a measure would not offer serious difficulties in the way of its execution.

PROTECTIVE FORESTS IN THE LIGNITIC BELT.

The elevation of the Lignitic Belt, which has permitted erosion, has resulted in a rough, broken country. The soils are loose and sandy, and but for the presence of the shortleaf and post oak forests would be washed in great quantities from the steeper slopes. Such soils have little capacity for retaining moisture. Annual plants of superficial root system can not flourish in them without abundant rainfall. A seasonal precipitation which would amply suffice for maturing crops in the compact, waxy soils of the Black Prairie to the west of the Lignitic Belt would in the latter, but for the forests, have the



FIG. 1.—COW OAK TIMBER (*QUERCUS MICHAUXII*) ON THE TRINITY IN LIBERTY COUNTY.



FIG. 2.—ALLUVIAL BOTTOM FOREST ON THE TRINITY IN LEON COUNTY.



effect of a drought. The forests, with their leafy litter and intermixture of humus, change the character of the soil sufficiently to raise the water level. Their removal would be followed by the washing away of the débris, loss of the organic matter from the soil, and a consequent sinking of the water level to a depth which would seriously affect the flow of springs and streams, as well as the crops. The result would be to make dry seasons, like that of 1901, far more disastrous and more common than they have been in the past.

It does not follow from this that clearing for agriculture should be restricted. The amount of heavy timber throughout the Lignitic Belt is so great and the land reforests itself so vigorously that danger from forest destruction is not at all imminent. In time, all of the land which can be brought into successful cultivation will be farmed. But there is much land which is too poor for permanent cultivation. The tendency in the region is to regard the timber as a nuisance, owing to its constant fight for possession and readiness to encroach. But for the good of the farms the poorer land on hills and high slopes should be kept timbered.

Under State ownership the quality of the forests needed for protection in this region would be greatly improved. It has already been said that there is no opening here for private management on a large scale to raise commercial timber. The heavy pine forests have been for the most part cut; more than half the area has no pine at all, and the prevailing upland oaks are of no value except for fuel and farm timber. State management, the occasion for which exists primarily in the fact that the interests of the community as a whole call for protective forests, would make possible a farsighted plan to secure the gradual replacement of the more valuable shortleaf pine. In this way the State would eventually have a large reserve area, which, besides being protective forests, would yield a revenue from the sale of valuable timber.

PROTECTIVE TIMBERLANDS ALONG WATER COURSES IN THE PRAIRIE REGION.

Unfortunately for Texas, her larger rivers have their sources in the arid plains at the base of the Rocky Mountains, where a protective timber growth is impossible. Several hundred miles of their upper courses run through treeless plains, upon which rainfall comes in sudden downpours amounting often to cloudbursts. Apparently, by far the larger part of the water so falling runs off in stream floods, carrying along enormous amounts of washed soil. The characteristic chocolate-colored floods rush away to the lower levels of the Coast Plain, where the slight fall in the water courses allows them to spread out over the valley, and when, as not infrequently happens, the streams

are already filled from local rains, the destruction is widespread. This happened in the Brazos flood of July, 1899, in the Colorado flood of April, 1900, when the Austin dam was carried out, and again in the Brazos flood later in the spring of the same year.

It is the opinion of many who have observed the recurrence of these floods for many years that they are growing in volume, if not also in frequency—a state of things quite to be expected from the breaking up of the protective grass covering by overpasturage along the upper courses of the rivers. Those who have ever seen the luxuriance of this grass vegetation will appreciate how great an influence it had in checking the run-off water and allowing it to sink into the soil. If this cover could be restored, the upper prairie region would be as efficiently protected as it could be by any timber vegetation capable of being established there.

It is in the middle courses of these streams, and on their numerous tributaries here, that a protective timber covering is needed. This is in the region of the Black and Grand prairies and the Carboniferous area westward. We have already seen that within this region we have the post oak of the Cross Timbers and the Carboniferous area, the river bottom timber, and the cedar and other species on the hills and bluffs along the river courses.

The value of this timber as a protective covering must be apparent from what has already been said. Its value as a source of local fuel, fencing, and other construction supplies has long been appreciated, because of the position of the region on the border of the endless stretches of untimbered prairie. Under these conditions, it is the opinion of the writer that the maintenance of the timberland here may be left to the cooperation of the farmers and ranchmen who own the land. Their own welfare will suggest it. There is needed only a campaign of education on the part of the State and Federal Government to cultivate a sentiment lively enough to lead to action, and to diffuse information as to how to act in the matter.

CONCLUSIONS.

The forest preservation which the interests of the State of Texas as a whole demand can be obtained only by the adoption of a definite State policy. Such a policy, to meet fully the needs of the situation, ought to include not only the fostering of private management, but also the establishment of State reservations. It ought to be conceived and administered on such permanent lines as to assure stable conditions to those whose cooperation is necessary. It ought to be at once scientific, availing itself of the best technical knowledge obtainable, and practical, adjusting itself to existing conditions and finding its support in the confidence and respect of the people with whom it must

deal. Its broad success will depend, not on its embodiment in legislation, but on its acceptance by the community at large.

The formulation of such a policy can best be brought about by the creation of a State board or commission. Such a commission might properly examine the workings of existing laws which affect the forests, and recommend changes or additions; arouse public interest and disseminate information concerning forest preservation; investigate the practicability of making reserves, and the area which might be included; and by cooperation with the Bureau of Forestry, or through such other means as it might find, secure the study of such scientific problems and the carrying on of such experiments as have an economic bearing on questions of forest utility in Texas. To this commission would also naturally fall the administration of the State reserves, should such be created by the legislature.

LIST OF VALUABLE TIMBER TREES NATIVE TO TEXAS, WITH NOTES ON THEIR DISTRIBUTION, HABITS, AND USES.

The following list is partly based on the writer's personal knowledge, partly compiled from such trustworthy publications dealing with the subject-matter as are available. Chief among the authorities which have been made use of are Sudworth's Check List of Forest Trees of the United States, Pinchot and Ashe's Timber Trees and Forests of North Carolina, and Havard's Botany of Southern and Western Texas. The first of these has furnished the basis of the list itself, with the ranges of the trees. The notes as to qualities, uses, etc., are derived largely from the second, while most of the notes on trees found west of the Pecos River are taken from the third. It is not to be supposed that the list is complete, and the information concerning the silvicultural characters, the distribution, and the number of the various trees is all too meager; but, in the absence of fuller knowledge, these notes may at least serve the purpose of a starting point for more exhaustive studies.

Limber pine (*Pinus flexilis* James).

In Texas the limber pine occurs only in the Guadalupe and Davis mountains, where it reaches a diameter of 12 to 18 inches. It yields inferior lumber.

Range.—Rocky Mountain region from Montana to western Texas; in mountains of northern Arizona, Utah, Nevada, and southern California.

Piñon, nut pine (*Pinus edulis* Engelm.).

The piñon, or nut pine, is common to the Guadalupe, Davis, Organ, and Chisos mountains. It is also found on the higher ridges of the Great Bend of the Rio Grande as far north as the Southern Pacific

Railroad, on the forks of the Nueces River, and along the edges of the high plateau of the Staked Plains. In the Chisos Mountains, which it occupies almost exclusively, it becomes a tree with straight trunk 1 foot in diameter, and could be sawn into useful lumber of fair quality. It reaches about the same proportions in the Davis and Organ mountains. Elsewhere it is seldom large enough for anything but fuel and fence rails.

Range.—From Colorado (eastern base Pikes Peak) through New Mexico and to western Texas.

Western yellow pine (bull pine) (*Pinus ponderosa scopulorum* Laws.).

The bull pine occurs on the higher slopes and in the upper canyons of the Guadalupe and Davis mountains. It is the prevalent and most valuable pine of these mountains, with a trunk 1 to 2 feet in diameter. The wood is hard, heavy, and durable, making excellent lumber and very good fuel.

Range.—From the interior of British Columbia, south of latitude 51, and the Black Hills region of Dakota, southward in the Pacific and Rocky Mountain regions to western Texas and Mexico.

Loblolly pine, old field pine (*Pinus taeda* Linnæus).

In Texas the loblolly pine occurs chiefly on the interior margin of the flat, low coast plain, from the Sabine River to Houston and north-westward. Here, on sandy knolls, it forms dense forests of large growth. On the lower, more compact soils it occurs in mixture with hardwoods. It bears seed in abundance, apparently every year, and is here, as elsewhere, aggressive in occupying old fields or clearings. The wood is light, not strong, brittle, very coarse-grained, and not durable. In color the heartwood is light brown, the very thick sapwood orange, or often nearly white. In Texas the saw products are sold as yellow pine lumber.

Range.—From Delaware to Florida and Texas, generally near the coast, and north to the valley of the Arkansas River. It reaches its best development in eastern North Carolina.

Shortleaf pine (*Pinus echinata* Mill.).

Occurs from the eastern border of Texas to Anderson and Madison counties, over an area of some 30,000 square miles. It occupies the higher interior portion of the Lignitic formation north of the longleaf area. Large tracts of pure forest formerly existed in Marion, Cass, and Bowie counties, but these have been largely cut out. Most of the area now contains pine in mixture with post oak and other upland oaks. It attains dimensions here equal to those in the region of its best development—3 to 4 feet and more in diameter, and 70 to 90 feet high. The wood is heavy, hard, strong, and generally coarse-grained, and is orange in color, with nearly white sapwood. As lumber it is inferior only to longleaf pine.

Range.—From Staten Island, N. Y., to Florida and Texas, through Arkansas to Indian Territory, Kansas, and Missouri, and in Illinois. Its best development is in Louisiana, Arkansas, and Texas.

Longleaf pine (*Pinus palustris* Mill.).

In Texas the longleaf pine area includes about 5,000 square miles east of the Trinity and interior to the coast prairie and the loblolly belt. It prefers the low sand ridges of this region, though much of it occurs on flat, poorly drained soils. In four years during which it was under observation by the writer, it seeded abundantly once, though a fair amount of seed is produced every year. Seedlings and saplings are generally absent from the forest; they are killed out by fire or excluded by shade from the old trees. Much damage is wrought by fungi, which cause "red heart" and doty wood. Old timber suffers little from fires.

This is the most valuable of all American pines for heavy construction timbers, and the best of the yellow pines for all kinds of lumber. The annual Texas product exceeds three-quarters of a billion feet.

Range.—The coast region from southern Virginia to Florida, and thence to eastern Texas. It reaches its best development in southwestern Louisiana.

Red fir (*Pseudotsuga taxifolia* (Lam.) Britton).

In Texas the Douglas spruce (known also as red fir, Douglas fir, red pine, etc.) occurs only on the higher slopes and in high canyons of the Guadalupe Mountains, where it is a large tree, next in prevalence and size to the yellow pine (bull pine). It grows to be from 30 to 50 feet high and from 1 to 2 feet in diameter.

Range.—From the Rocky Mountain region in the United States northward to central British Columbia, and on the Pacific coast.

Bald cypress (*Taxodium distichum* (Linnæus) Richard).

The cypress occupies, either as a fringe of timber or in considerable bodies, the swamps and bayous east of the Trinity, especially in the low coast country. Westward, it occurs occasionally along the banks of streams, reaching far into the canyons of the Edwards Plateau, where specimens attain 6 feet or more in diameter. Only in places difficult of access does the cypress remain uncut. The lumber is much on the market now as shingles and for finishing—especially for doors—as well as for larger construction. The wood is light, soft, close and straight-grained, not strong, compact, easily worked, and very durable in contact with the soil; light or dark brown in color, the sapwood nearly white.

Range.—From southern Delaware southward in the coast region to Florida, and thence westward in the Gulf coast region through Texas to Devils River, and northward through Louisiana, Arkansas, and

eastern Mississippi and Tennessee, southeastern Missouri, western and northwestern Kentucky, southern Illinois, and southwestern Indiana.

Red juniper, red cedar (*Sabina virginiana* (Linnaeus) Antoine).

The red cedar occurs in the alluvial valleys of the Brazos, Red, San Bernard, and other rivers. Here it grows in mixture with dense hardwood timber and shrubbery. Most of the better timber has been removed. What remains is being marketed as piling and telegraph poles. From Columbia, near the San Bernard brakes, about 100,000 cedar poles were marketed in 1900. Sticks large enough for piling are rare. The short, even sticks are sold for lead-pencil stock. The heartwood is a dull red.

Range.—Nova Scotia and New Brunswick to Florida, and west in Ontario to Dakota, central Kansas, and Indian Territory. The Rocky Mountain and western red cedar, hitherto called *Juniperus virginiana*, is a distinct species.

Mountain juniper (*Sabina sabinoides* (H. B. K.) Small).

The species occurs on limestone hills, often where very little soil exists. Its characteristic occurrence is in impenetrable brakes. The tree branches profusely from the ground, hence clear timber is rare. The wood is extremely durable and finds very general use as posts, poles, ties, sills, fences, and for all sorts of construction, and for fuel. The leaves are small and more compactly arranged than in the red cedar; bark of branches mottled with white and dark patches; wood brown in color. It is the most valuable tree of the semiarid hill country of Texas.

Range.—Especially abundant in the hilly Edwards Plateau country of central Texas, but also found on rocky hills and bluffs northward toward the Red River, and southwestward and westward as far as beyond the Pecos, and probably into Mexico.

One-seed juniper (*Sabina monosperma* (Engelmann) Small).

Occurrence in western Texas is not well defined.

Range.—From the eastern base of the Rocky Mountains of Colorado southward into western Texas, and from southern Utah to central New Mexico and Arizona.

Alligator juniper, thick-bark juniper (*Sabina pachyphloea* Antoine).

This juniper is found in moderate abundance in the Guadalupe, Davis, and Eagle mountains. It has a trunk from 1 to 2 feet in diameter, but is seldom more than 10 feet high. The wood is reddish, close-grained, and very hard and durable.

Range.—The tree occurs in southwestern Texas and westward on desert ranges of New Mexico and Arizona south of the Colorado River Plateau, in the mountains of northern Arizona, and in Mexico.

Black walnut (*Juglans nigra* Linnæus).

One of the valuable hardwoods of the alluvial bottoms of the north-eastern part of the State. Most of the available big timber has been marketed. On the upper Sabine the species attains large proportions. On the western margin of its range it is dwarfed.

Range.—From southern Ontario to Florida, central Alabama, and Mississippi, and westward through southern Michigan, Wisconsin, and Minnesota to Nebraska, Kansas, and in Texas to the San Antonio River. The tree reaches its best development in the rich bottomlands of southwestern Arkansas and Indian Territory and on the western slopes of the Allegheny Mountains.

Mexican walnut (*Juglans rupestris* Engelman).

A small tree, becoming shrubby, and of interest chiefly as representing the black walnut in the arid Southwest.

Range.—Along the streams in the Edwards Plateau region of central Texas, and westward into New Mexico and Arizona and southwest into Mexico.

Pecan (hickory) (*Hicoria pecan* (Marsh.) Britton).

The pecan is native on alluvial soils of river bottoms of the Trinity and westward to the Concho. It becomes a very large tree, 3 to 4 feet in diameter, but of medium height (40 to 60 feet), with a very broad spread of crown. The tree is much cultivated in the middle western counties. Nuts are produced in abundance once in two or three years, and find a ready market. The wood has in general the qualities of the other hickories.

Range.—From Iowa through southern Illinois and Indiana, western Kentucky, and Tennessee, to central Alabama and Mississippi; through Missouri and Arkansas, Indian Territory, western Louisiana, central Texas, and Mexico. It has been considerably extended by cultivation.

Bitternut (hickory) (*Hicoria minima* (Marsh.) Britton).

The occurrence of this hickory in Texas is not yet sufficiently determined.

Range.—From southern Maine and Ontario to Florida; west through central Michigan to Minnesota, Nebraska, Kansas, Indian Territory, and Texas as far as the Trinity River.

Water hickory (*Hicoria aquatica* (Mich. f.) Britton).

This tree is very abundant on low stream banks and bayous, especially near Orange. Its occurrence elsewhere is not determined. It is a small tree of minor value and not easily accessible.

Range.—From Virginia through the coast region to Florida; along the Gulf shore to Texas and northward to southern Illinois. The best development is on the lower Mississippi and Yazoo rivers.

Shagbark (hickory) (*Hicoria ovata* (Mill.) Britton).

In Texas this is the most valuable hickory; it occurs on alluvial bottomlands, attaining a diameter of 2 to 3 feet and a height of 60 to 80 feet. The wood is heavy, very hard and strong, tough, close-grained, compact, and flexible. It is light brown in color, with the thin and more valuable sapwood nearly white. It is largely used for agricultural implements, carriages, ax and tool handles, baskets, and fuel.

Range.—On rich hillsides and on sandy ridges from the valley of the St. Lawrence River to Michigan and southeastern Minnesota, southward to western Florida, central Alabama, and Mississippi, and westward to eastern Kansas, Indian Territory, and eastern Texas, reaching its best development west of the Allegheny Mountains.

Mocker nut (hickory) (*Hicoria alba* (Linn.) Britton).

Occurrence in Texas is not sufficiently determined, but it is said to be rather abundant on the rivers in the coast country—e. g., on the San Bernard—and to attain large size. Its use is the same as the shagbark hickory.

Range.—Ontario to Florida, and west to Missouri, eastern Kansas, Indian Territory, and Texas (Brazos River).

Pignut (hickory) (*Hicoria glabra* (Mill.) Britton).

In Texas this hickory is one of the upland hardwoods in the short-leaf and post oak areas of the Lignitic Belt. It appears to be rather common and only of medium size—50 to 70 feet tall and 1 to 2 feet in diameter.

Range.—This hickory occurs on dry hills and uplands from southern Maine to southern Ontario, southern Michigan, Minnesota, the eastern parts of Nebraska and Indian Territory, and south to western Florida and southern Texas. It reaches its best development in the lower Ohio basin.

Common cottonwood, necklace poplar (*Populus deltoides* Marsh.).

In Texas this cottonwood is found in abundance along the banks and often covering the first bottoms of streams, far out into the prairie regions. Its region of best development is in the Red River Valley, where it occurs near the stream in pure forest. Farther back, on the alluvial bottom, it is mixed with many other hardwoods, and attains a height of 100 to 150 feet and a diameter of 4 to 8 feet. It is now extensively used for finishing lumber and for drawers, backs, and partitions in furniture. The demand for cottonwood lumber is increasing. The wood is very light, soft, not strong, close-grained, and compact; liable to warp and hard to season.

Range.—From Quebec and Vermont, through western New England and New York, Pennsylvania (west of the Alleghenies), Maryland, and the Atlantic States to western Florida, and west to the Rocky Mountains from southern Alberta to northern New Mexico.

Fremont cottonwood (*Populus fremontii* Watson).

Although not specifically determined, it is probable that the Fremont cottonwood takes the place of the common species west of the one hundredth meridian in Texas. Cottonwood of large size occurs about springs and in watered canyons in all of west Texas and up the Rio Grande to El Paso. In some of the side canyons of the Rio Grande it has been found as large as 5 feet in diameter. The wood of the western specimens—presumably the Fremont cottonwood—is of finer quality than the eastern, and is higher priced.

Range.—Western California to Lower California, and eastward to central Nevada, southern Utah and Colorado, western Texas, and Northern Mexico.

River birch (*Betula nigra* Linnæus).

In Texas the river birch is one of the river-bottom species, frequenting especially the higher river banks. It does not appear to reach large dimensions, but information as to its occurrence is meager. The wood is used for furniture, woodenware, wooden shoes, ox yokes, turning, etc.

Range.—Massachusetts to Florida, and west to Nebraska and to the Trinity River in Texas.

Hornbeam (*Ostrya virginiana* (Miller) Koch).

The hornbeam is rather abundant in the river bottoms of the loblolly belt and Big Thicket country, but does not often exceed 1 foot in diameter. The wood is heavy, very strong, hard, tough, very close-grained, compact; light brown in color, or often nearly white, like the sapwood. It is used for posts, levers, mill cogs, wedges, mallets, and the handles of tools.

Range.—Nova Scotia to northern Florida, and west to Dakota and eastern Texas.

Ironwood, blue beech (*Carpinus caroliniana* Walter).

Abundant and well developed in eastern Texas. It is known especially in the Big Thicket country. It prefers thick, shady woods and wet, alluvial soils. The wood and its uses are much the same as of the preceding.

Range.—Much the same as that of the hornbeam.

Beech (*Fagus atropurpurea* (Marsh.) Sudworth).

The beech is common along the east Texas streams except where the ground is swampy. It appears to average 40 to 60 feet in height and 1 to 2 feet in diameter. The wood is not used here.

Range.—Nova Scotia to Lake Huron (north shores) and northern Wisconsin; south to western Florida, and west to southeastern Missouri and eastern Texas (Trinity River).

Chinquapin (*Castanea pumila* (Linnæus) Miller).

Data are wanting as to the abundance of chinquapin in east Texas, but in certain localities (e. g., near Nacogdoches) there are groves of trees of large size. Nuts are commonly produced in abundance, and find a good market.

Range.—From southern Pennsylvania to northern Florida and eastern Texas (Neches River).

White oak (*Quercus alba* Linnæus).

The identity and occurrence of the true white oak are not determined for Texas. White oaks there are in great abundance, but those examined by the writer are not *Q. alba* Linnæus.

Range.—From southern Maine to Florida, and west to Nebraska and Texas.

Post oak (*Quercus minor* (Marsh.) Sargent).

This is by far the most abundant oak in Texas. It occupies gravelly clay or sandy upland soils in the Lignitic Belt, extending southwestward along the Fayette Prairie formation to Carrizo Springs. The "Cross Timbers," composed of this species, are found in the granite and carboniferous areas of central Texas to the one hundredth meridian. The post oak forest is heavy in east Texas, open and orchard-like westward. Eastward it attains a normal height of 60 to 80 feet and diameter of 3 to 4 feet. Westward the height is from 30 to 50 feet and the diameter 1 to 2 feet.

In all of the drier parts of its Texas range the post oak is likely to be diseased. Doty wood caused by fungous growth and dwarfed and misshaped limbs are common. The wood is durable in contact with soil, and has been used for railway ties and local construction. Great quantities are consumed as fuel, both in the timber belt and in the towns and cities of the Black Prairie. Elsewhere the wood is said to be used for cooperage, shipbuilding, and carriage stock.

Range.—Widely distributed over the eastern half of the United States.

Bur oak, mossy-cup oak (*Quercus macrocarpa* Michaux).

This is a very abundant and valuable tree in east Texas, where it attains a height of 100 feet and a diameter of 3 to 4 feet on the rich, alluvial river bottoms. On the lower Trinity and San Jacinto it is common. It occurs sparingly in the canyons of the Edwards Plateau, where it reaches a good size, considering the aridity. The wood of the bur oak is heavy, hard, strong, compact, and very durable in contact with the soil. It is used in shipbuilding, cooperage, furniture, etc., and is said to be the equal of white oak for these purposes. In Texas much of it has been used for railway ties and staves.

Range.—Eastern North America from New Brunswick and Nova Scotia to Pennsylvania, west to Montana (east base of Rocky Mountains), and southwestward into Texas to the Nueces River.

Overcup oak (*Quercus lyrata* Walter).

In the Red River Valley above Texarkana the overcup oak is the most common of the large trees. In some places it stands almost in pure forest. Specimens reach 100 feet in height and 3 to 5 feet in diameter. In the southern half of east Texas the tree is very common. It prefers wet, rich alluvial soils. In 1901 it bore acorns in great abundance. The wood has the qualities of white oak, and is used for the same purposes. The Texas product has been used for ties and staves.

Range.—In wet soils from Maryland to western Florida, and westward to the Trinity River in Texas. It reaches its best development in the valley of the Red River and adjacent portions of Arkansas and Texas.

Cow oak (*Quercus michauxii* Nuttall).

The cow oak occurs most abundantly on the San Jacinto River and its forks, and is generally abundant in the coast plain forest, especially in the "Big Thicket" country. It thrives in wet, alluvial soils, but not on swampy soil. It reaches 5 and 6 feet in diameter. This is a white oak somewhat similar in appearance to *Q. alba*, with wood much of the same quality and suitable for the same uses.

Range.—From Delaware to northern Florida; west through the Gulf region to Texas (Trinity River), and through Arkansas and southeastern Missouri to central Tennessee and Kentucky, Illinois, and Indiana.

Texas white oak (*Quercus pogonæfolia* (Ell.) Ashe).

This species is very common in the lower coast plain forest on the San Jacinto and Trinity rivers. It is confused here with the genuine *Quercus alba*. In this locality the tree becomes 80 to 100 feet high and 2 to 4 feet in diameter.

Durand oak (*Quercus breviloba* (Torr.) Sargent).

This is one of the most abundant mountain oaks of the Edwards Plateau. The tree is small—20 to 30 feet high and 6 to 14 inches in diameter—but on the high divides it becomes dwarfed to a mere shrub whose aggregation comprises the "Shinneries" common in dry, hilly country. The wood is probably superior to post oak, but it is used mainly for fuel.

Range.—In the Gulf States from central Alabama across middle and southern Texas.

Live oak (*Quercus virginiana* Miller).

The live oak occurs in great quantity and perfection in the coast country from the Brazos to the Nueces (becoming dwarfed westward, however). It also extends northward well across the State on the Black and Grand prairies. The tree seems to prefer heavy, waxy clay soils, but it is found upon the river bottoms in the lower country.

The live oak here has usually a short, thick trunk and very broad crown. The trunk diameter reaches 5 and 6 feet, and the crown spread over 100 feet.

Range.—From Virginia, on islands and near the coast, to and through southern Florida and along the Gulf coast to western Texas. Also in Lower California, southern Mexico, Central America, and Cuba.

Small mountain live oak (*Quercus fusiformis* Small).

A form of Virginia live oak growing upon rocky, semiarid hills in the Cretaceous areas of central Texas.

Emory oak (*Quercus emoryi* Torrey).

Abundant in some of the canyons and along the southern base of the Davis Mountains, and forms the exclusive arboreal growth of some of the canyons of the Chisos Mountains. In the former habitat it is a handsome tree, with tall, straight stem, 1 to 3 feet in diameter. In the Chisos Mountains it seldom exceeds 12 inches. The wood is hard and valuable as timber and fuel.

Range.—Mountains of western Texas and of New Mexico and Arizona south of the Colorado plateau, and the mountains of north Mexico.

Texas red oak (*Quercus texana* Buckley).

The occurrence of the Texas red oak in this State is undetermined. It is the tallest and perhaps the largest of oaks.

Range.—The Mississippi Valley States from Iowa to Texas. The mountain form in Texas has been separated as *Quercus schneckii* Britton.

Mountain Spanish oak (*Quercus schneckii* Britton).

This is the most common oak in the Edwards Plateau region of Texas. It is a small tree, 5 to 10 inches in diameter and 20 to 30 feet high, occurring on the more stable slopes and hilltops. It often forms dense timber on sides of gorges, where by collecting much débris it aids the formation of rich soil, which it prevents from being washed away. The wood is good for posts and rails. It is much in demand locally for fuel, and all of the sizable trees are being cut. Acorns are produced in abundance, and young timber readily establishes itself.

Spanish oak (*Quercus digitata* (Marsh.) Sudworth).

This is believed to be the very common red oak of the sandy uplands in the shortleaf belt in east Texas. At Glendale and Nacogdoches, for example, it is very abundant and of large size, with very wide spread of crown. Its maximum height of 100 and diameter of 6 feet is closely approached here, though the average is smaller. The wood is heavy, very hard, strong, not durable, coarse-grained, and checks badly in drying. It is light red in color—the sapwood lighter. It is used for cooperage, construction, and very largely for fuel. The bark is rich in tannin.

Range.—From southern New Jersey to central Florida, and through the Gulf States to eastern Texas (Brazos River), Arkansas, southwestern Missouri to middle Tennessee and Kentucky, southern Illinois, and Indiana.

Black jack (*Quercus marilandica* Muenchhausen).

In Texas the black jack is common—often abundant—on all sandy clay or gravelly uplands. It reaches a height of 50 to 60 feet and diameter of 1 to 3 feet, but is smaller in the western part of its range. It accompanies the post oak in the Lignitic Belt, in its southwestward extension in the Cross Timbers, and in the granite and Carboniferous areas of central Texas, reaching to the one hundredth meridian. Eastward the tree is used only for fuel; westward it furnishes certain construction material for the regions in which timber is scarce.

Range.—Eastern United States, New York to Florida, and west to the one hundredth meridian.

Water oak (*Quercus nigra* Linnæus).

In Texas the water oak is very abundant along the bayous and in swampy bottoms as far west as the Colorado River. It attains in these situations large proportions, averaging probably 3 feet in diameter and 60 to 70 feet in height. The water oak has been used only for fuel and minor purposes. The wood is heavy, hard, strong, coarse-grained, and compact, rather light brown in color; the sapwood, lighter.

Range.—Southern Delaware to Florida; west to the Appalachian Mountains and through the Gulf States to Texas (Colorado River); northward to Arkansas, southern Missouri, Kentucky, and Tennessee.

Blue jack (*Quercus brevifolia* (Lamark) Sargent).

The occurrence and quantity of blue jack is not well determined. It appears to be one of the common upland oaks in the shortleaf pine belt.

Range.—From North Carolina (maritime belt) to Florida; west on the Gulf coast to Texas (Brazos River, and inland as far as Dallas).

Cedar elm (*Ulmus crassifolia* Nuttall).

In Texas the cedar elm is abundant along streams west of the Lignitic Belt, becoming a large and beautiful tree in the bottoms of the Colorado and Brazos rivers from near the coast through the Cretaceous regions. Here the height attained reaches 50 to 70 feet and the diameter 3 feet. In the Edwards Plateau country, cedar elm is common on the uplands wherever rich soil has collected, but here it is small—20 to 40 feet tall, and 8 to 12 inches in diameter. At Austin the wood is used for fuel. It is, however, inferior for this, but would probably be useful in turnery, woodenware, posts, and small timbers.

Range.—From Mississippi through southern Arkansas and Texas (from the coast to the Pecos River) to Mexico (Nuevo Leon).

Slippery elm (*Ulmus pubescens* Walter).

The occurrence and habits of this elm in Texas are not sufficiently determined.

Range.—Eastern North America from the lower St. Lawrence River to Florida, and west to North Dakota and Texas (San Antonio River).

American elm (*Ulmus americanus* Linnæus).

In Texas the American elm is very common and of fair size along streams on the prairie, and in the Lignitic Belt it grows very large on porous sandy soils, even of the flat uplands, reaching a height of 80 to 90 feet and a diameter of 4 feet. The wood is heavy, hard, strong, tough, rather coarse-grained, compact, and difficult to split; the heartwood is light brown; the sapwood lighter. It is used for wheel stocks, saddle trees, flooring, and cooperage, and is exported for boat and ship building. In Texas the wood is used only locally.

Range.—Eastern North America from Newfoundland to Florida, and west to the base of the Rocky Mountains and to the Concho River in Texas.

Hackberry (*Celtis occidentalis* Linnæus).

In Texas, the hackberry is one of the commonest trees on the streams of the prairie region. It occurs both in the interior of the Lignitic Belt (northeast Texas) and on the uplands in the Cretaceous region (Edwards Plateau and northward).

At San Antonio and westward, the straight, short trunk ranges from 6 to 24 inches in diameter; on the lower Rio Grande it reaches greater proportions, being often 20 feet long and 2 to 3 feet in diameter, the total height being 50 feet or more. The wood is heavy, rather soft, not strong, coarse-grained, compact, clear light yellow; the sapwood, lighter. It is largely used for fencing and occasionally, since it takes a good polish, in the manufacture of cheap furniture.

Owing to its hardness, the hackberry has been much planted for shade on streets and in parks. With favorable, preferably deep alluvial or loamy soil and plenty of water, it makes a beautiful tree. Otherwise it is dwarfed and unsightly and much disfigured by leaf galls.

Range.—Eastern North America from St. Lawrence River to Florida; west to New Mexico and the Pacific Northwest.

Red mulberry (*Morus rubra* Linnæus).

The red mulberry is common in the heavy hardwood bottom forests of east Texas and in similar situations on the lower Colorado and Brazos rivers. The tree is only a small one, probably seldom exceeding 1 foot in diameter, and forms an inconsiderable item in the sylvia, so far as yet determined.

Range.—Eastern United States from Massachusetts to Florida and west to Nebraska, Kansas, and Texas (Colorado River).

Osage orange (*Toxylon pomiferum* Rafinesque).

Northeastern Texas, where formerly there were large quantities of very fine timber, is within the zone of best development of the Osage orange. Here it occurs on alluvial bottom soils, and attains a height of 60 feet and a diameter of $2\frac{1}{2}$ feet. The wood is hard, very strong, dense, and durable; in color, bright orange. Its weight per cubic foot is 48 pounds. It takes a fine polish and is very decorative, and could be well used in interior finish and cabinet work. No data are at hand at present to indicate how extensively it is so used in Texas. At Gainesville, much Osage orange, or "bodark" (bois d'are), has been sawn into lumber. Much has also been shipped out for posts.

Range.—From southern Arkansas (south of Arkansas River) through southeastern Indian Territory and southern Texas to about latitude $36^{\circ} 56''$. It is widely distributed elsewhere by cultivation.

(Evergreen) magnolia (*Magnolia fetida* (Linnaeus) Sargent; *Magnolia grandiflora* Linnaeus).

In Texas the magnolia is very abundant and large in the half swampy lowlands of the coast belt. Here it reaches a height of nearly 100 and a diameter of over 4 feet. The wood is moderately hard, close-grained, not strong, easily worked, not durable in contact with the soil; creamy white in color; the thick sapwood nearly white. Although well suited for cabinetwork and interior finish, the wood is little used. Magnolia is one of the most promising of the hitherto unused Texas hardwoods.

Range.—Coast region of North Carolina to Florida, and westward in the Gulf coast region through western Louisiana to southern Arkansas and Texas (Brazos River).

Sweet gum (*Liquidambar styraciflua* Linnaeus).

In Texas the sweet gum is very common, and attains large dimensions on the wet lower lands of the Lignitic Belt, occurring also to a considerable extent upon loamy uplands. It attains at least a height of 100 feet and a diameter of 4 to 7 feet on alluvial soils.

The wood is heavy, hard, not strong, rather tough, close-grained, and liable to warp and shrink. It takes a good polish and is used for cabinetwork, veneering, flooring, clapboards, barrels, and street paving. Sweet gum occurs in such size and quantity as to make it another of the promising trees among the unused Texas hardwoods.

Range.—From Connecticut to southeastern Missouri and Arkansas; south to Florida and Texas (Trinity River).

Sycamore (*Platanus occidentalis* Linnaeus).

In Texas the sycamore is common on all the streams of the Lignitic Belt of the central prairie region, and in the Coast Plain from the Trinity to the Rio Grande and Devils River. It prefers the immediate banks of streams where these have cut through a considerable depth of

sandy clays or alluvium. The wood is heavy, hard, not strong, very close-grained, compact, difficult to split and work; brown in color. It decays rapidly in contact with the soil or on exposure, and warps and cracks badly in drying. It is used for ox yokes, butchers' blocks, interior finish, furniture, and very largely for tobacco boxes.

Range.—Eastern United States from New Hampshire to eastern Nebraska, and south to Florida and Texas.

Black cherry (*Prunus serotina* Ehrhardt).

Small specimens of black cherry are frequent along the gorges in the Edwards Plateau. There is no specific information as to its abundance in east Texas. Even the small trees are sought for by cabinetmakers.

The largest and best trees in all parts of the Eastern United States have already been cut.

Range.—From Nova Scotia to Tampa Bay in Florida, west to North Dakota, eastern Nebraska and Kansas, Indian Territory and Texas; also in southern New Mexico and Arizona, and in parts of Mexico and Central and South America.

Texas ebony (*Zygia flexicaulis* (Bentham) Sudworth; *Acacia flexicaulis* Bentham).

This is a shrub or small round-headed tree, with handsome evergreen foliage, and is common on the bluffs of the lower Rio Grande and Gulf Coast. Its straight trunk is seldom over a foot in diameter. The wood is heavy and compact, with the several shades of ebony, and taking nearly as fine a polish; hence its great value to cabinetmakers. Ebony posts are reputed the most durable of any made from Texas woods, and may be said to last forever.

Range.—Gulf coast of Texas (from Matagorda Bay) to Mexico (Sierra Madre Mountains in Nuevo Leon); Lower California.

Huisache (*Acacia farnesiana* (Linnaeus) Willdenow).

The huisache has come to be very abundant, both by cultivation and natural spreading, through the coast country from Galveston westward and as far north as Brenham and San Antonio. In many places it covers the coast prairie like a beautiful orchard. The trunk seldom exceeds a foot in diameter. The rose-colored wood is hard and compact, excellent for cabinetwork. Huisache posts rank next to those of mesquite in durability.

The huisache is one of the most promising species for cultivation in parks and residence grounds. It stands several degrees of frost easily. At Austin 3° below zero failed to kill several old trees in February, 1899. Near Galveston during the same freeze the spring was well started and the air moist; 8° above zero killed much of the huisache to the ground, but it has since grown out from the stumps.

Range.—Native in America from Rio Grande River to Northern Chile; also in Australia and subtropical Africa; naturalized in West

Indies, Guiana, Brazil, Argentina, India, Southern China, Indian Archipelago, and islands of the Pacific; widely cultivated and naturalized from the Gulf Coast region to southern California, and also in Mediterranean countries.

Mesquite (*Prosopis glandulosa* Torr.).

The mesquite varies in size with conditions, attaining a height of over 30 and a diameter of 2 feet in the lower Rio Grande Valley, averaging 20 feet high and 5 to 10 inches diameter on prairies in central Texas, where it has long been established, and reduced to mere switches on the lower half of the Staked Plains.

Its spread has carried some serious evils in its train, but on the other hand a great deal of fencing and fuel material has been gained, and a very considerable amount of forage.

The tree is of great general utility because of the hard, heavy, compact, and durable quality of the wood. It is used for posts, ties, paving blocks, underpinning, etc., and is an especially good fuel. It should be especially fine for cabinetwork. Other features which can be merely mentioned here are its yield of gum (like gum arabic), tannin, and nutritious bean pods.

Range.—Widely distributed through the arid southwest (Lower Sonoran zone) from about the ninety-seventh meridian in middle Texas to California, Lower California, and into northern Mexico; in the Andean region of South America to Chili, Argentina, and southern Brazil; also in the West Indies.

In Texas the mesquite has for fifty years been crowding up from the southwest and overrunning the prairies to the north and eastward, having passed beyond the Colorado—indeed, to the Brazos—in central and southern Texas, and along the foot of the plains to Oklahoma and even southern Kansas.

Black gum (*Nyssa sylvatica* Marsh.).

In Texas the black gum is very abundant on low, alluvial soils and even in water soaked, swampy places. The Red River bottom and Sulphur Fork have areas covered with almost pure forest of black gum, which attains a height of near 100 feet and a diameter of 3 to 4 feet. The wood is heavy, strong, soft, very tough, and hard to split and work; inclined to check and not durable in contact with the soil; light yellow or nearly white in color. It is used for wheel hubs, rollers in glass factories, ox yokes, shoes for horses in rice fields, wharf piles on the Gulf coast, and soles of shoes. The black gum has scarcely come into demand in Texas yet.

Range.—From Maine to Florida and west to southern Ontario, southern Michigan, southeastern Missouri, and eastern Texas (Brazos River).

Tupelo gum, cotton gum (*Nyssa aquatica* Linnæus).

The tupelo is abundant in the swamp and bayou type of forest, especially in the coast country east of the Trinity. It attains large dimensions—80 to 100 feet in height and 3 to 5 feet in diameter. The wood is light, soft, not strong, close-grained, compact, not wedgeable, and light brown or nearly white in color. It is used for turning; wooden ware, broom handles, and wooden shoes, and for vegetable boxes and crates.

A few lots of tupelo have been sawed in Texas to test its value and desirability for making cheap crates, boxes, etc.

Range.—Coast region from southern Virginia to northern Florida, west through the Gulf States to eastern Texas, and northward up the Mississippi Valley to southern Illinois.

White ash (*Fraxinus americana* Linnæus).

In east Texas the white ash grows abundantly and of large size in alluvial river bottoms. It attains a height here of 100 feet or more and a diameter of 3 to 5 feet.

Most of the ash that stood near railways has been removed; also much has been rafted down the Trinity. The supply has been thus very much reduced. A relatively small amount has been consumed by local furniture factories.

Range.—From Nova Scotia and Newfoundland to Florida, and westward to Ontario and northern Minnesota, eastern Nebraska, Kansas, and Indian Territory and Texas (Trinity River).

Green ash (*Fraxinus lanceolata* Borkh.).

This ash appears to be abundant in eastern and southern Texas along the river bottoms, but the facts of its occurrence are not distinguished from the white ash. The wood is inferior in quality to that of the white ash.

Range.—In Eastern United States, from Vermont to Florida; westward to the eastern ranges of the Rocky Mountains and extending into the Wasatch Mountains of Utah and mountains of northern Arizona; in eastern Texas to the Colorado River.

INDEX.

	Page.
<i>Acacia</i> , species, ranges and uses	64
Agriculture in post oak country, remarks	27-28
American elm, range and use	62
Ashes, ranges and uses	66
Atlantic tree species, Edwards Plateau, Texas list	30
Bald cypress, range and use	53
Bayou and swamp forests of east Texas belt	16-17
Beeches, ranges and uses	57
<i>Betula nigra</i> , range and use	57
"Big Thicket," Hardin County, Tex., note	20
Birch, river, range and use	57
Bitternut, range and use	55
Black and Grand prairies, extent, rainfall, etc	10
cherry, range and use	64
gum, range and use	65
jack oak, range and use	61
walnut, range and use	55
Blue jack, range and use	61
"Bodark" (Bois d'arc), range and use	63
Bottoms, alluvial, hardwood forests	17
lumbering in hardwoods	40
Bull pine, range and use	52
Bur oak, exclusiveness of growth in Red River Valley	18
range and use	58
Canyons, high, timber in Texas	35
<i>Carpinus caroliniana</i> , range and use	57
<i>Castanea pumila</i> , range and use	58
Cedar brakes, Edwards Plateau, Texas, remarks	30-31
elm, range and use	61
red, range and use	54
<i>Celtis occidentalis</i> , range and use	62
Central Denuded Region, extent, etc	10
Chaparral, Rio Grande region, Texas, discussion	33-34
Cherry, black, range and use	64
Chinquapin, range and use	58
Classification, forest, in Texas, discussion	15-36
Climate, Texas, relation to forest growth	7
Climatic conditions, Texas, relation to forest extension	41
Coast Plain, Texas, extent, rainfall, soils, and forests	8
Cordilleran Region, Texas, extent, rainfall, etc	11
remarks on timber	34
Cotton gum, range and use	66
Cottonwoods, range and use	56, 57
Cow oak, range and use	59
Cretaceous Belt, extent, rainfall, soil, and forest condition	10
Cypress, bald, range and use	53
Louisiana and Texas, notes	17
Disease and injurious insects, forest, Texas losses	44
Durand oak, range and use	59

	Page.
Ebony, Texas, range and use	64
Edwards Plateau, extent, rainfall, etc	10
protective forests	47-48
timber and grass land, extent	29
Elms, ranges and uses	61-62
Emory oak, range and use	60
Engelmann, remarks on tree species in Texas	29
<i>Fagus atropunicea</i> , range and use	57
Farmer, timber and fuel supply, note	41
Fayette Prairie, extent, rainfall, soils, and forest growth	8
longleaf pine forests, discussion	21-23
Fir, red, range and use	53
Fire, forest, protection, remarks	43
prevention of, renewal of forest	38
Fires, cedar brake, loss	31
longleaf pine forest, remarks	22-23
prairie, relation to timber in Texas, note	28
Floods, Texas, relation to grass and timber, remarks	49-50
Foothills and slopes, Texas, timber	35
Forest, classification for Texas, discussion	15-36
distribution in Texas, determining causes	11-15
extension, Texas, discussion	41-42
effect of hurricanes	15
extent and character on interior of Texas Coast Plain, discussion	19-20
hardwood and loblolly pine of east Texas, future	21
shortleaf, Lignitic Belt, extent, composition, etc.	24-28
of Texas bottoms, composition and condition	18
longleaf pine, conservative lumbering, discussion	37-39
Fayette Prairie, Texas, progress of use	23
management and the State, Texas, discussion	43-45
private, remarks and notes	37-42
Texas, discussion	36-37
preservation, Texas, conclusions as to demands	50-51
renewal, prevention by fire	38
reserve in longleaf pine area, Texas, arguments	46-47
Forested belt, chaparral on Rio Grande Plain, remarks	33
Forestry, Bureau, study of longleaf pine in Texas	38
work in Texas, note	36
Forests, character in several Texas areas	8, 9, 10, 11
protective in longleaf pine belt, Texas	45-47
zones in Texas corresponding to rainfall zones	11-12
<i>Fraxinus</i> species, ranges and uses	66
Fremont cottonwood, range and use	57
Fuel, use of cedar in Texas, remark	30
Fungous disease in Texas forest, note	44
Geographic relation of tree species on Edwards Plateau, Texas	29-30
relations of Texas forested region	33
Geographical position, Texas, general statement	7
Geologic conditions of post oak forest, remarks	26
formation in Texas Coast Plain, remark	20
Geological formation, relation to vegetation, note	28
Grass prairie, transformation into timberland in Texas	28
Green ash, range and use	66
Gulf hurricanes, relation to forests in Texas	15
Gum, sweet, range and use	63
Gums, ranges and uses	63, 65-66
Hackberry, range and use	62
Hardwood and shortleaf forests, Lignitic Belt, Texas, discussion	24-28
forest and loblolly pine of Texas Coast Plain, discussion	19-20
forests of alluvial bottoms, conservative lumbering	40
in Texas, discussion	17
timber, east Texas, extent, value and prospect	19
Havard, remarks on Texas timber	35

	Page
Hickories, ranges and uses	55-56
<i>Hicoria</i> , species. (See Hickories.)	
Hill, Prof. R. T., description of river bottomlands	17
Hill timber on Edwards Plateau, Texas	31-32
Hornbeam, range and use	57
Huisache, range and use	64
Humus, destruction of material by fires in longleaf pine, note	22-23
Hurricanes, Gulf, effect on forest extension in Texas	15
Immigration, Texas, relation to forest, note	40
Insects and diseases, forest, Texas losses	44
Ironwood, range and use	57
<i>Juglans</i> , species, ranges and uses	55
Junipers, ranges and uses	54
Lignitic Belt, Texas, extent, soil structure, rainfall, and forest	8-9
hardwood and shortleaf forests, discussion	24-28
protective forests, remarks	48-49
Limber pine, range and use	51
Live oak timber belt in Texas, discussion	32-33
oaks, ranges and uses	59-60
Loblolly pine and hardwood forest of Texas Coast Plain, discussion	19-21
forests, conservative lumbering	40
range and use	52
Longleaf forests of Fayette Prairie, discussion	21-23
pine belt, protective forests, discussion	45-47
forest, Texas, conservative lumbering, discussion	37-39
range and use	53
Louisiana, value of swamp forest, note	17
Lumber, amount cut annually in Texas	36
high-grade, increase in price probable	39
longleaf pine, amount cut annually in Texas	37
Lumbering, conservative, Texas, discussion	37-41
methods, Texas, modification necessary	38
rate and prospects in longleaf pine, Fayette Prairie, Texas	23
shortleaf, extent in Texas	25
Magnolia (evergreen), range and use	63
Management, conservative, of woodlots, discussion	40-41
forest, and the State, Texas, discussion	43-45
in Texas, discussion	36
private, conclusions	42
private, promotion, remarks	43-44
State, Texas, of forests, remarks	45
Manufacturing, use of hardwood timber in east Texas	19
Mesquite, range and use	65
spread in Texas and character of growth	34
Mexican tree species, Edwards Plateau, Texas	30
walnut, range and use	55
Mimosa, occurrence on Rio Grande Plain, note	33
Mocker nut (hickory), range and use	56
Mohr, Doctor, statements as to southern timber	37
Moisture and temperature, relation to forest extension	41
<i>Morus rubra</i> , range and use	62
Mossy-cup oak, range and use	58
Mulberry, red, range and use	62
Nut pine, piñon, range and use	51
<i>Nyssa</i> , species, ranges and uses	65-66
Oak, bur, exclusiveness of growth in Red River Valley	18
live, timber belt in Texas	32-33
post, forest, Lignitic Belt, character, value, agriculture, etc	26-28
white, destruction by hurricane in Texas	15
Oaks, ranges and uses	58-61